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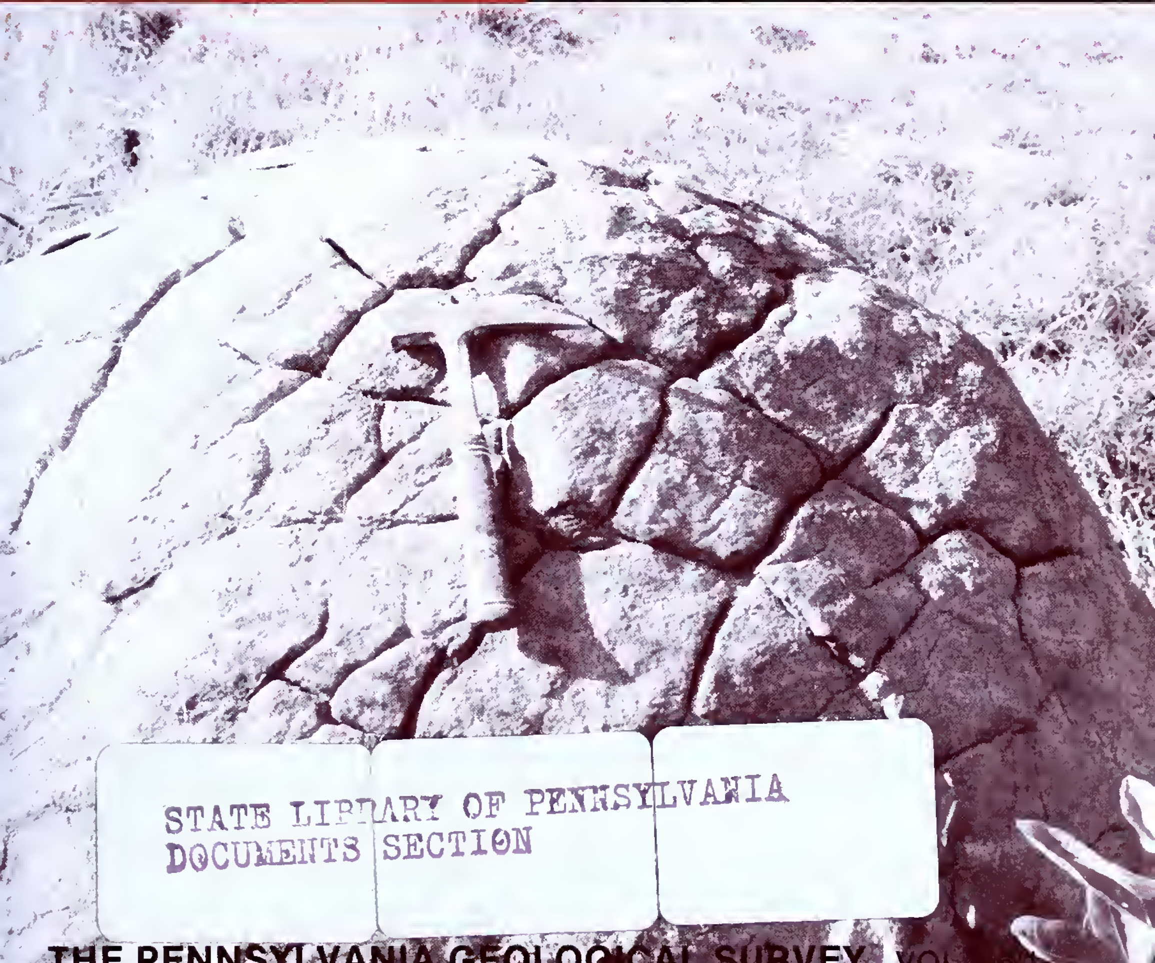
PENNSYLVANIA GEOLOGY



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THE PENNSYLVANIA GEOLOGICAL SURVEY VOL

COMMONWEALTH OF PENNSYLVANIA
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TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: Boulder of Triassic age diabase, near Wellsville, York County, shaped by spheroidal weathering. Polygonal joint pattern, formed when the molten rock cooled, is accentuated by the weathering. Photo courtesy of Robert C. Smith II.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

VOL. 16, NO. 1 **FEBRUARY, 1985**

FROM THE DESK OF THE STATE GEOLOGIST

AS THE FEDS BOW OUT

As has been mentioned here on numerous occasions, our progressing economic society and our increasing environmental awareness has steadily resulted in an expanding need for geologic maps and geologic evaluations. Detailed geologic maps and data base are essential as we are being called upon to provide technical input into such matters as waste disposal locations, mine land restoration, land use planning, power plant siting, mineral land evaluations, landslide assessment, and sinkhole repairs.

While our State Geologic Survey is faced with an increasing demand for geologic data and services, as is the case with most other State Geologic Surveys across the country, the geologic mapping and detailed investigations by the U.S. Geological Survey and the U.S. Bureau of Mines has been decreasing, particularly in the eastern United States. The declining federal involvement is in part a reflection of the federal manpower and budget reductions and partly the result of Congressional mandates directing the federal capability toward studies on major federal landholdings, which happen to be in the western states and Alaska.

We look back with nostalgia to the first 60 years of the century when the U.S. Geological Survey had literally scores of geologists, actually living and working in Pennsylvania, doing geologic mapping, mineral resource investigations and detailed coal investigations; today there are none. Where once the U.S. Bureau of Mines provided mining and geologic services throughout the state, today that staff and service capability is a shadow of its former self.

With the evaporation of federal geologic activities in our state, we at the Pennsylvania Geological Survey face the responsibility of providing the geologic data and services for which, as indicated above, we are increasingly being called upon by fellow government agencies and the public. Accordingly, we have to plan our geologic programs and utilize our staff judiciously to meet those needs. In an era of our own very real budget and manpower limitations, it makes for an interesting challenge.

Arthur A. Socolow

SILICA
99 AND 44/100% PURE, WAITING TO BE MINED!

by Robert C. Smith, II,
and S. W. Berkheiser, Jr.

Better than Ivory Soap? Not for washing, but one of the largest exposed and easiest to mine pure milky quartz veins (Figure 1) found to date in Pennsylvania contains about 0.2% of metals other than silicon. This quartz vein forms the top of an unnamed ridge near Pine Grove Furnace, Cumberland County, Pennsylvania, which is located in Michaux State Forest, 0.50 mile NW of the intersection at Pine Grove Furnace, Cooke Township. It has a maximum elevation of 1085 feet. The latitude and longitude of the occurrence are 40°02′23″N, 77°18′27″W.

The quartz vein has a true thickness of at least 12 to 17 feet near the center of the outcrop and is 360 feet long in a northwest-southeast direction (Figure 2). Based on the outcrop pattern and measurements of a few schistose inclusions, the vein dips to the southeast and forms a topographic slope. Near the middle, the surface width (dip slope) of outcrop is estimated to be approximately 225 feet, bringing its southeastern edge down to an elevation of about 1015 feet. Abundant, moderately large float boulders of quartz continue to the southeast to Toms Run.

A 12-1/2-foot-long channel sample was collected on the northwest side of the vein. The composite sample was found to contain only 0.24% Al_2O_3 and 0.1% Fe_2O_3, as well as less than 200 parts per million (ppm) Ca, less than 10 ppm Cr, 300 ppm Mg, 30 ppm Mn, 50 ppm Ti, and less than 20 ppm Zr. Other than quartz, the only observed materials in the vein are sparse greenish muscovite and iron stains on broken surfaces. Estimates of the quantity of quartz range from 65,000 to 320,000 tons, depending on the assumed dip of the vein. Probably at least 100,000 tons are potentially mineable. Little or no overburden removal would be required. The host rock to the vein is a metavolcanic schist, the composition of which appears to be intermediate between rhyolite and basalt.

Potential uses for milky quartz such as this range from decorative to high-technology. Decorative uses include exposed aggregate in pre-cast

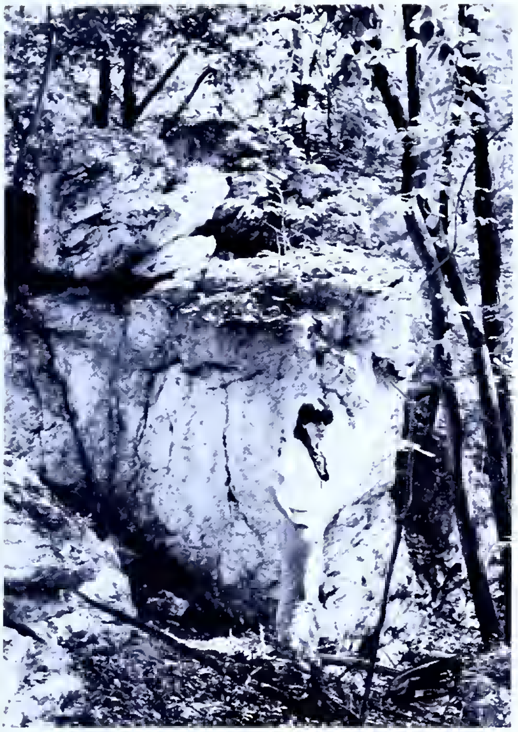
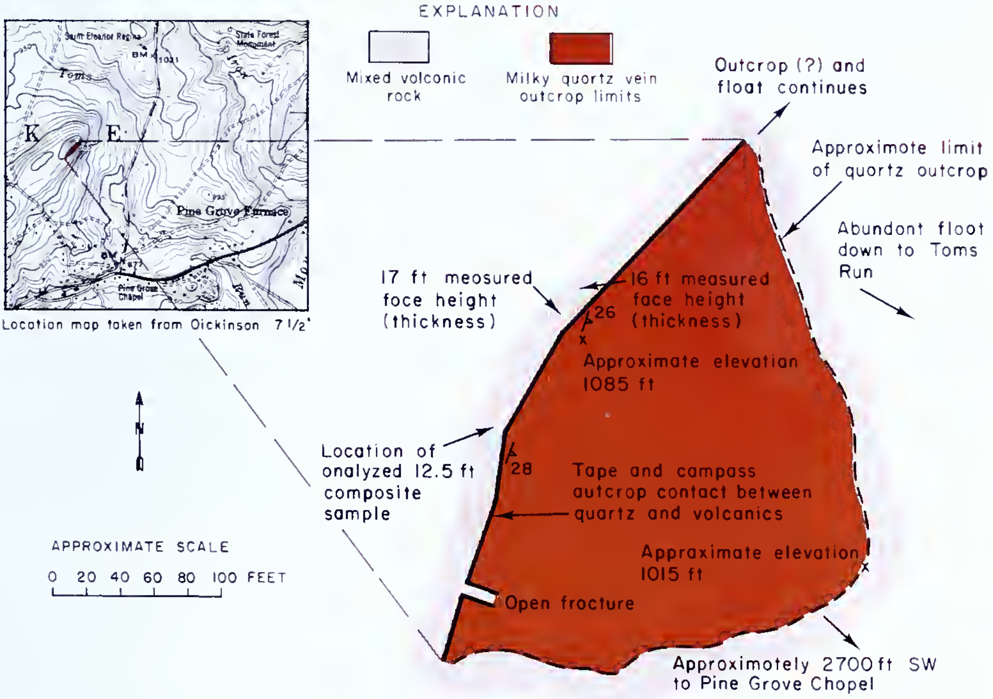


Figure 1. Quartz vein (sample location) on northwest side of Toms Run quartz vein. Geologic Aide (for scale) is about 5 ft tall. Foliation dips to the left of the photo at about 28° SE.



EXPLANATION
Mixed volcanic rock
Milky quartz vein outcrop limits
Saint Eleanor Regina
BM × 1021
State Forest Monument
Toms
K
E
Pine Grove Furnace
Pine Grove Chapel
Location map taken from Dickinson 7 1/2'
N
APPROXIMATE SCALE
0 20 40 60 80 100 FEET
Outcrop (?) and float continues
Approximate limit of quartz outcrop
Abundant float down to Toms Run
17 ft measured face height (thickness)
16 ft measured face height (thickness)
26
Approximate elevation 1085 ft
Location of analyzed 12.5 ft composite sample
28
Tape and compass outcrop contact between quartz and volcanics
Approximate elevation 1015 ft
Open fracture
Approximately 2700 ft SW to Pine Grove Chapel

Figure 2. Sketch map of Toms Run quartz vein showing outcrop pattern and sample location.

concrete panels. If beneficiation is feasible (current lab-scale tests of similar quartz veins occurring elsewhere in Pennsylvania have been successful), the quartz might be used for refractories and metallurgical quartz. High-technology uses of beneficiated material might include the manufacture of a fumed product used in the production of fiber-optics, as well as use as a raw material for manufacturing polycrystalline silicon used by the solar photovoltaic and electronics industry.

Although the occurrence was briefly noted by Stone (1939), no evidence of exploration or development was observed. Stone notes that the locality was known as "White Rocks" (a name more commonly associated with sandstone or quartzite ledges elsewhere in Pennsylvania) and that freight-car loads strew the surface. He also notes a possible 50-foot-wide vein along strike to the northeast, where it crossed Pa. Route 233, one mile south of the crest of South Mountain. Data on several other, generally purer, quartz veins and rather pure sedimentary deposits (Smith and Berkheiser, 1983) are being described in an upcoming reconnaissance report on high-purity silica occurrences in Pennsylvania (Berkheiser, in press).

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Surplus Topographic Maps

The Survey has accumulated a quantity of outdated 7½, quadrangle topographic maps for eastern Pennsylvania. We are offering them, in limited numbers, to teachers and troop leaders.

If you are interested in receiving a limited number of these maps contact Arthur A. Socolow, State Geologist, Dept. of Environmental Resources, Bureau of Topographic and Geologic Survey, P.O. Box 2357, Harrisburg, PA 17120. Maps will be supplied as long as they last on a first-come first-serve basis. Orders for specific quadrangles cannot be accepted.

NEW ROCK MAP OF PENNSYLVANIA

Geologic maps are often somewhat of a mystery to the layperson. The large number of different formation names that may be shown on a geologic map can be very confusing to some. In order to help the non-geologist understand more about the distribution of different kinds of rock in the Commonwealth, the Pennsylvania Geological Survey has published a new map titled *Rock Types of Pennsylvania* (Map 63). This full color map of the state shows 19 basic rock types (or groupings of rock types) such as shale, quartzite, slate, redbeds, sandstone, conglomerate, limestone, igneous rocks, etc. Map 63 is published at a scale of 1:500,000 or 1 inch equals approximately 8 miles. *Rock Types of Pennsylvania* is a simplification and reduction of the new Geologic Map of Pennsylvania (Map 1) issued in 1980, which shows over 180 different groups, formations, and members ranging in age from Precambrian to Recent. Map 63 makes no attempt to show geologic age relationships.

Map 63 is intended for use by all laypersons of all ages. It will be useful for science and earth science classes in junior and senior high schools, and will also be useful for many introductory earth science college courses. The map will be a tremendous aid to the traveler who is interested in knowing the relation between Pennsylvania's scenic ridges and valleys and the underlying rocks. Those interested in the human history of the Commonwealth may find answers to why trade routes were located where they are, and why the location of certain mineral resources had such a profound impact on our development.

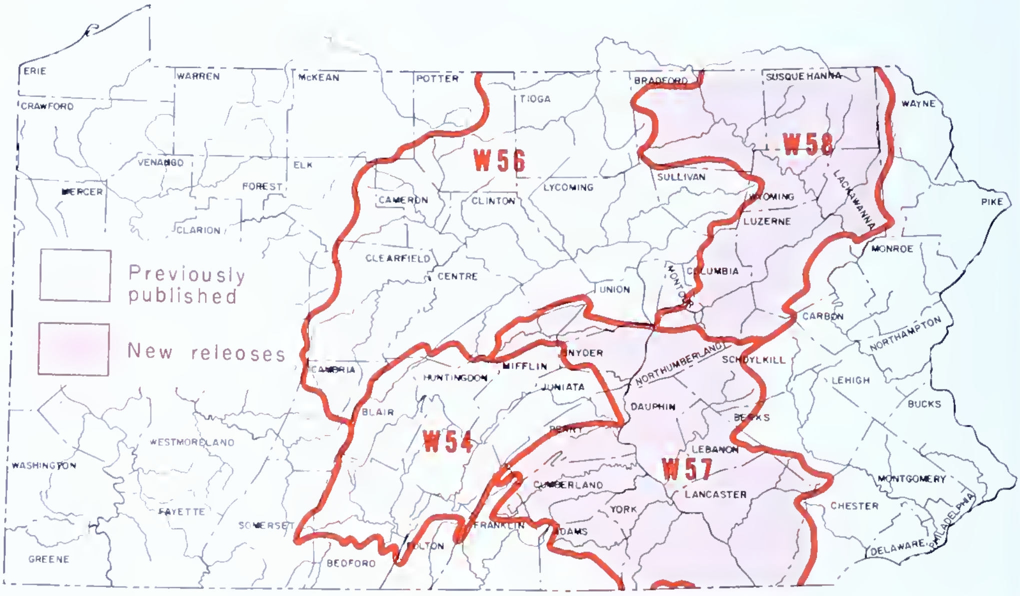
Rock Types of Pennsylvania was compiled by T. M. Berg and W. D. Sevon of the Pennsylvania Geological Survey, and R. Abel of the Defense Mapping Agency. The map is printed on a base which shows major roads, county and city boundaries, a latitude/longitude grid, and all water bodies and rivers. The map is folded in a handy envelope and is available from the State Book Store, P.O. Box 1365, Harrisburg, PA 17105. The price is $4.35 (plus 26¢ sales tax for Pennsylvania residents); please make check payable to "Commonwealth of Pennsylvania."

GROUNDWATER RESOURCES OF THE SUSQUEHANNA RIVER BASIN— LATEST PUBLICATIONS COMPLETE SERIES

With the Pennsylvania Geological Survey's recent publication of two groundwater reports, *Groundwater Resources of the Lower Susquehanna River Basin* (Water Resource Report W 57) and *Groundwater Resources of the Upper Susquehanna River Basin* (Water Resource Report W 58), a series of four reports detailing the hydrogeology of the Susquehanna River basin in Pennsylvania is now available.

These reports contain a substantial amount of new data relative to the quantity and quality of groundwater in the basin. They were prepared as part of the three-year Special Groundwater Study of the Susquehanna River basin by the Susquehanna River Basin Commission (SRBC) in cooperation with various state and federal agencies. Anyone involved with any aspect of water resource utilization and management will find these reports to be an extremely valuable addition to their libraries.

The publications are available from the State Book Store in Harrisburg or by mail. Water Resource Reports W 57 and W 58 are priced at \$15.70 (plus 94¢ tax for Pennsylvania residents) and \$13.95 (plus 84¢ tax for Pennsylvania residents), respectively. Send mail orders to the State Book Store, P. O. Box 1365, Harrisburg, PA 17105. Make check payable to the "Commonwealth of Pennsylvania."



BASS ISLANDS PRODUCTION IN NORTHWESTERN PENNSYLVANIA

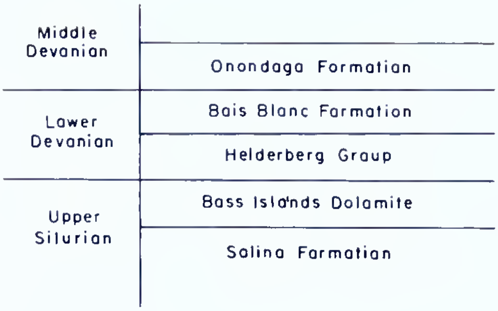
by
Robert M. Harper

Appalachian operators are producing high gravity crude oil and natural gas in New York's Chautauqua and Cattaraugus Counties, adjoining Pennsylvania. The oil and gas are produced from a zone extending from the basal portion of the Middle Devonian Onondaga Formation down into the Upper Silurian Bass Islands Dolomite (Figure 1). Production occurs from fractured reservoir intervals along a fault trend which strikes approximately N55°E across Chautauqua and western Cattaraugus counties (Figure 2) (Van Tyne, 1983). Copley and others (1982) identified the trapping mechanism as a low-angle reverse or thrust fault. Drilling depths through the production zones are reported to average 3,000 feet and initial potentials are stated as greater than 10 MMcfpd for natural gas and up to 500 bbls of oil per day per well (Copley and others, 1982).

Harper and Abel (1981) suggested that the structural trend in New York, along with other similar trends mapped in western New York by Van Tyne (1982), may extend southwestward into northwestern Pennsylvania (Figure 2). The purpose of this article is to describe the stratigraphy of this subsurface interval in northwest Pennsylvania, recount the history of petroleum exploration and development in the Upper Silurian-Lower Devonian carbonates of northwestern Pennsylvania and discuss the relationship of recent production from this zone in northwestern Pennsylvania to the "Bass Islands" play of western New York.

The area of interest in this article is Erie County, in the north-central portion of the Appalachian geosyncline. During most of the middle Paleozoic (Silurian-Devonian) the Erie County area was near the central portion of the Appalachian basin (Kelley and McGlade, 1969).

The Middle Devonian to Upper Silurian stratigraphy includes the Onondaga Formation, Bois Blanc Formation, Helderberg Group, and the Bass Islands Dolomite (Figure 1). These formations will be discussed separately. The Lower Devonian Oriskany may be present in northwest Pennsylvania, though its occurrence is patchy. To date, the Oriskany has not been encountered by drilling in the study area and will not be discussed here.



Middle Devonian	Onondaga Formation
Lower Devonian	Bois Blanc Formation
	Helderberg Group
Upper Silurian	Bass Islands Dolomite
	Salina Formation

Figure 1. General stratigraphic column of the productive interval in the Greenley Pool of Erie County.

The subsurface Middle Devonian Onondaga Limestone is dominated by a moderately deep water carbonate facies which grades northward into shales and cherts (Kissling and Polasch, 1982). The Onondaga consists of finely crystalline limestone somewhat silty and argillaceous, with some chert (Jones and Cate, 1957). The terrigeneous clastics appear to have an easterly source (Cate, 1957). In south-central New York and northwestern Pennsylvania, basin and platform are joined by a south-sloping ramp (Kissling and Polasch, 1982) built by limestone deposition. Bioherms are also present in this area. The bioherms are not wave-resistant reefs; instead they formed at considerable water depths.

The Lower Devonian Bois Blanc Formation is a thin and discontinuous unit beneath the Onondaga. This formation apparently thins and becomes more clastic eastward (Lytle and others, 1977). In western New York, the Bois Blanc is a medium dark-gray, fine-grained limestone. Although the Bois Blanc fauna contains many corals, it is numerically dominated by brachiopods (Oliver, 1967). It is widespread and covers most of eastern North America. The Bois Blanc is representative of a shallow sea that supported abundant life.

In northwest Pennsylvania the Lower Devonian Helderberg is interpreted from lithologic evidence as having originated in a shallow water environment (Jones and Cate, 1957). Fettke (1961) describes the Helderberg of northwestern Pennsylvania as a very fine limestone, crystalline to dense,brownish-gray to gray, somewhat sandy and magnesian; containing considerable light brownish-gray chert with some silt, and in part minutely porous. There is gradual thinning of the Helderberg toward the northwest (Jones and Cate, 1957).

The Upper Silurian Bass Islands is a carbonate unit including limestone, dolomitic limestone, and dolomite. This unit was deposited in an elongate trough basin trending northeast-southwest (Cate, 1965). In northwestern Pennsylvania there appeared during Bass Islands "time" the reactivation of a positive element, a sort of shoal perhaps, plunging slightly westward and trending almost east-west along the Erie-Crawford County boundary (Cate, 1965). Little facies change is evident in the Bass

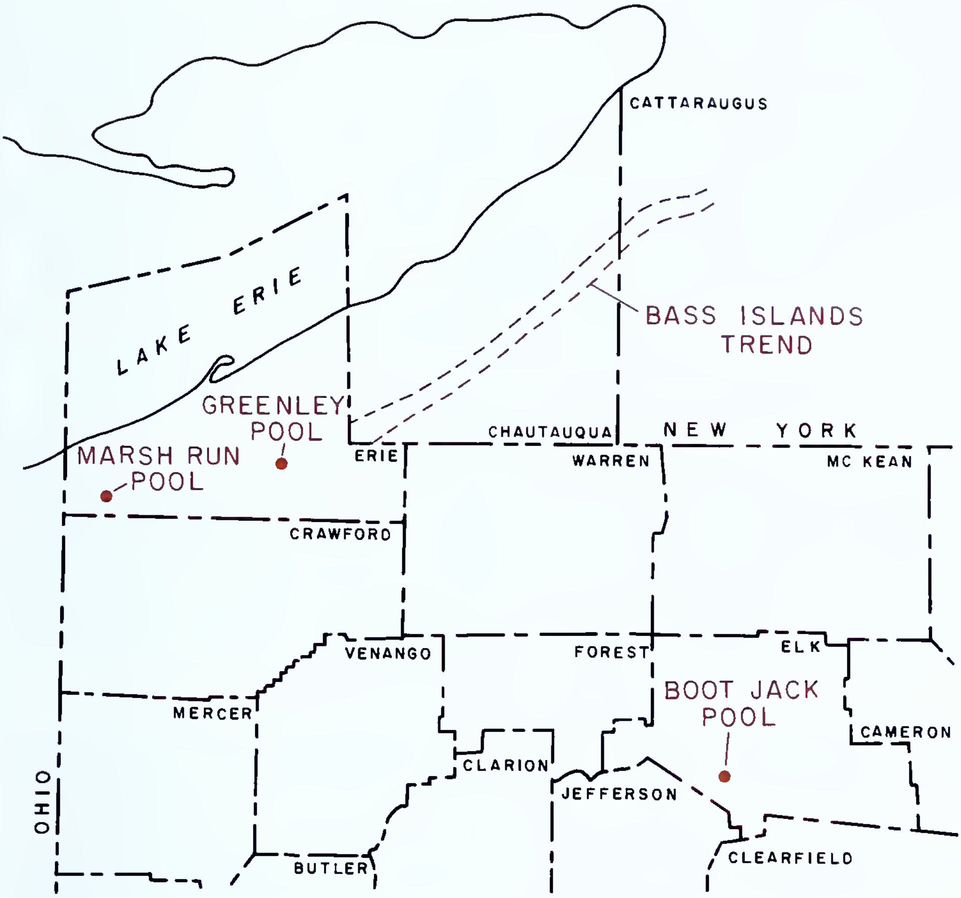


Figure 2. Bass Islands trend in western New York and productive areas in Pennsylvania. New York Fairway mapped by Van Tyne (1983) and discussed by Copley, et. al, 1982.

Islands, and most likely structure will play a major role in the entrapment of gas in this horizon (Kelley and McGlade, 1969).

The first reported discovery of natural gas in Pennsylvania's Bass Islands occurred in 1973. This discovery occurred in the Boot Jack Pool of Elk County (Figure 2), a deeper pool discovery in the Horton Field on the Hebron anticline. It should be noted that the use of the name "Bass Islands" this far southeast is questionable; Abel and Heyman (1981) suggest the Shriver Chert or Mandata Shale may be present instead in this area. Production was from the interval between 6,470 feet and 6,492 feet. Initial production was 531 Mcf. Boot Jack's cumulative production at the end of 1983 was 11,275 Mcf from one well (Harper, 1984). The trapping mechanism at this pool is probably controlled by anticlinal development. This pool was shut-in in 1978.

In 1982, the Marsh Run Pool was discovered in western Erie County (Figure 2). Production was from the interval between 2,125 feet and 2,203 feet. Cumulative production from this pool at the end of 1983 was 858 Mcf from two wells (Harper, 1984). Given the history of Bass Islands production in New York, the Marsh Run Pool may be controlled by the same type of faulting that occurs in that state. This faulting is thought to be caused by movement in the underlying Salina salt. This pool is still producing natural gas. Cumulative production of Bass Islands natural gas, excluding the discovery at Greenley Pool which will be discussed next, was 12,133 Mcf at the end of 1983 (Harper, 1984).

Recent drilling activity has produced good results from these carbonates in eastern Erie County. The production interval is from Lower Devonian Bois Blanc to Upper Silurian Bass Islands in the Greenley Pool of Drumlin Field (Figure 2). Initial potentials range from 4,000 Mcf in the Bois Blanc Formation, in NRM Petroleum Corporations's No. 1 Mitchell-Kestle well, to 27,000 Mcf in the Bass Islands Formation, in N.E.A. Cross Company's No. 1 Serwinski well. The reservoirs are encountered at an average depth of 2,654 feet in Greenley Pool.

Can Greenley Pool be an extension of the Bass Islands trend in New York? Geographically, the Greenley Pool appears to be on the same northeast-southwest trend described by the New York investigators. From all data available it is reasonable to interpret the production in the Greenley Pool as controlled by the same type of thrust faulting that controls the Bass Islands play in New York. The faulting may have occurred through activation of growth faults in the Salina (Figure 3). A growth fault is formed during deposition. This faulting probably occurred during Salina deposition. In Figure 3, the structure section shows the strata was thrust up above well number ERI-23628, which has been pushed down. Production is from well number ERI-23508 and well number ERI-23595, which are stratigraphically the highest wells. The gas migrated up until it was trapped by an impermeable layer of stratum. This is the mechanism responsible for Bass Islands production in this area.

So why doesn't Greenley Pool produce both oil and gas from the same zone as in New York? Harris (1979) mapped conondont thermal alteration indicies in the central Appalachian basin; the alteration index is about 2 in the Silurian through Middle Devonian carbonates near Greenley Pool. This value suggests burial temperatures of 60 to 140°C. The reported conodont alteration indicies are approximately equivalent to vitrinite reflectance values of 0.85 – 1.3 (Harris, 1979). These values indicate that any kerogen in the Silurian through Middle Devonian interval at Greenley Pool is thermally mature. It is probable that oil and gas could have been

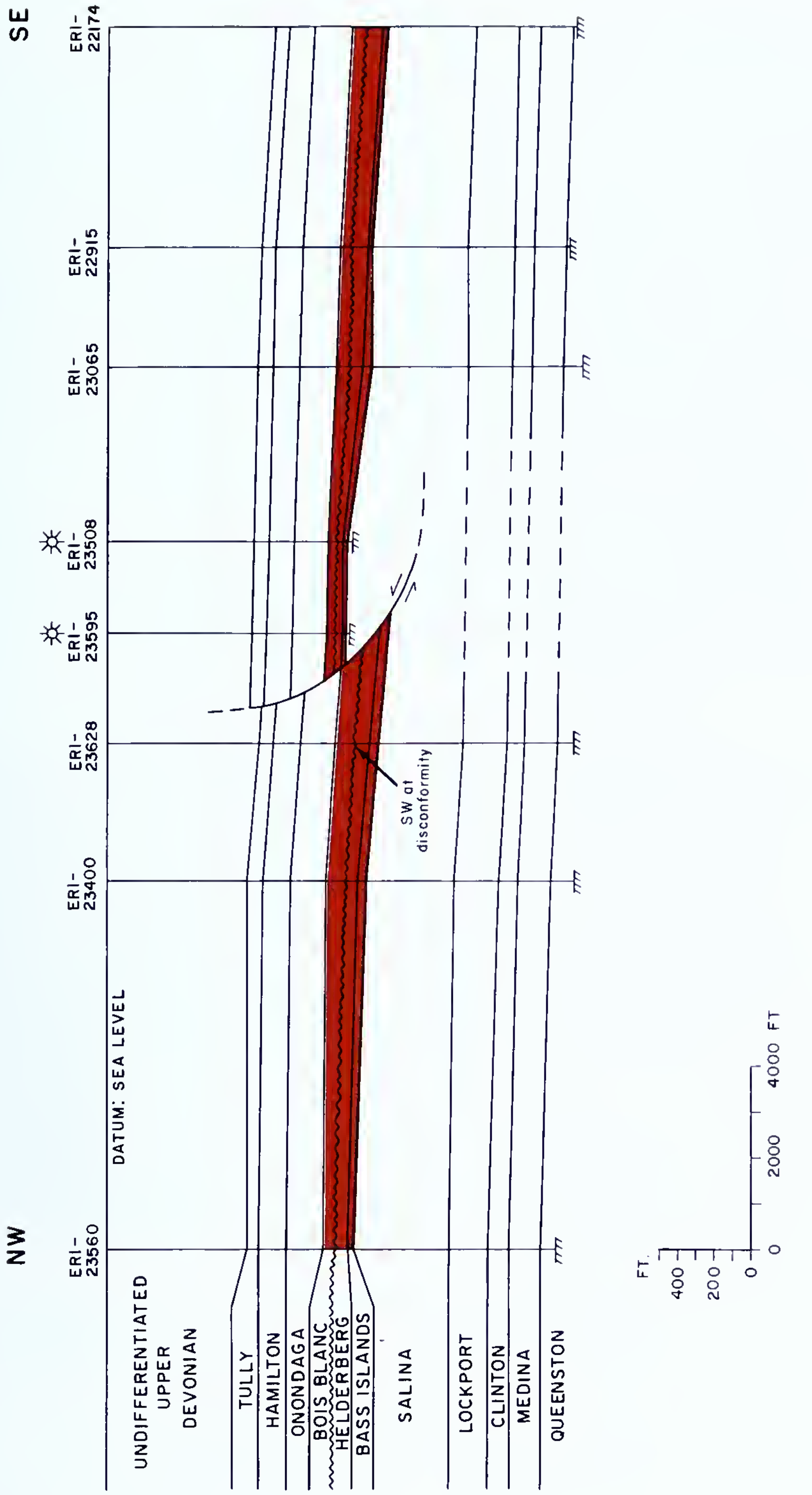


Figure 3. Cross section showing interpreted trapping mechanism for Bass Islands production in Greenley Pool.

generated in this interval. The organic carbon content of these carbonates, however is generally low throughout Pennsylvania (Christopher Laughrey, per. comm.), on the average of 0.3%. An organic carbon content of at least 0.6% is required for oil generation (Tissot and Welte, 1978). There are suitable source beds, however, above the productive section in Greenley Pool. In a nearby well in Erie County, the Marcellus Shale has an organic carbon content of nearly 4% (Streib, 1981). Magara (1973) suggests that overpressuring of shales can lead to the development of a subsurface pressure barrier and force the migration of hydrocarbons downward. The difference in produced fluids at Greenley Pool and southwestern New York reflects a complex petroleum migration history which we do not quite understand.

From the information that has been gathered, it seems the the Bass Islands trend does extend into Pennsylvania from New York. Further exploration along this northeast-southwest trend is expected and will lead to a better understanding of this play in Pennsylvania.

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U.S. Geological Survey Increases Map Prices Effective January 1, 1985.

The U.S. Geological Survey has increased the prices for all map series. The prices of the maps most often requested are listed.

Standard Topographic Maps	1:24,000	$2.50
County Maps	1:50,000	4.00
30 x 60-minute maps	1:100,000	4.00
Intermediate Scale Maps	1:250,000	4.00
State Topographic Maps	1:500,000	4.00

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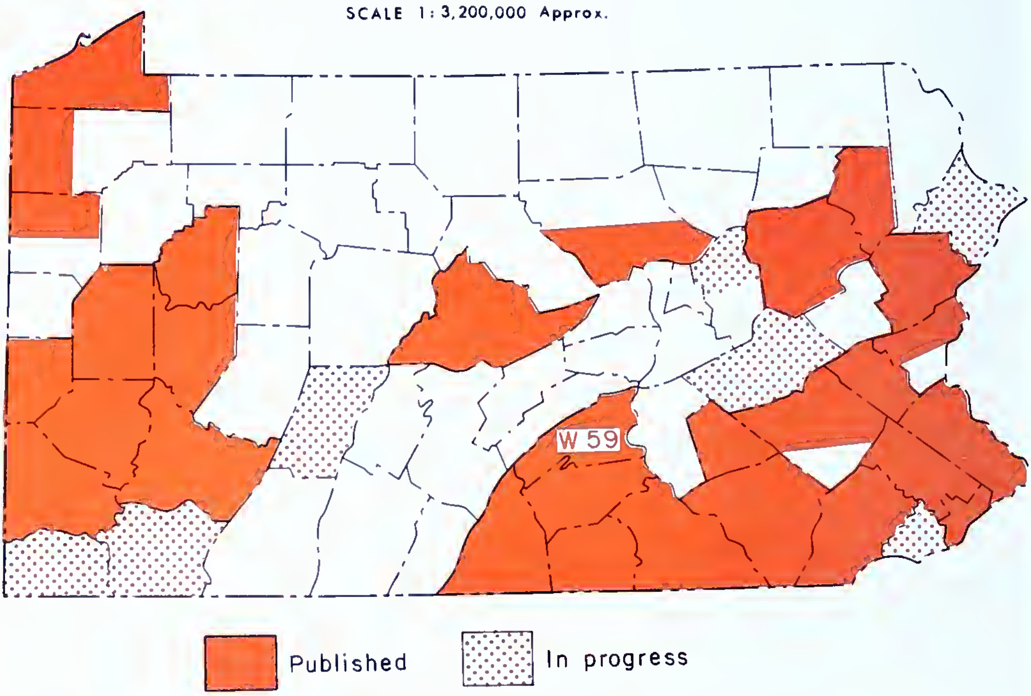
NEW SURVEY PUBLICATIONS

Perry County Groundwater

Water Resource Report W 59, *Summary Groundwater Resources of Perry County* by Denise W. Royer, describes the virtually untapped groundwater resources of this county. Based on the annual water-budget analysis of the county roughly 397 (gal/min)/mi^2 of groundwater is available and only 4.7 (gal/min)/mi^2 was reportedly used in 1981.

The report includes a record of wells, a 20-year annual water budget and baseflow frequency curve for Sherman Creek basin, and descriptions of the aquifers, well and yield characteristics, and drinking water quality. Accompanying the text is a full-color geologic map (scale 1:50,000) with locations of 473 inventoried wells and a detailed legend. The report should be on interest to anyone who is planning for future water needs in Perry County.

Water Resource Report W 59 is available through the State Book Store, P. O. Box 1365, Harrisburg, PA 17105 for $15.30 (plus $.92 tax for Pennsylvania residents). A check made payable to the Commonwealth of Pennsylvania must accompany the order.

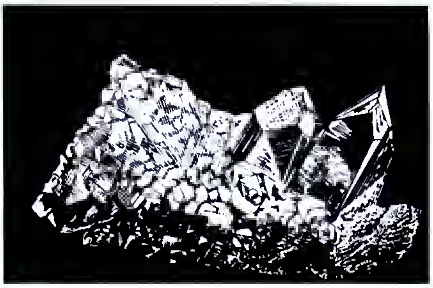


Copper-Uranium Occurrences Report Issued

A report on the *Geology and Mineralogy of Copper-Uranium Occurrences in the Picture Rocks and Sonestown Quadrangles, Lycoming and Sullivan Counties, Pennsylvania,* by Robert C. Smith, II, of the Pennsylvania Geological Survey and Donald T. Hoff of the Pennsylvania Historical and Museum Commission, is now available from the State Book Store. Of the 271 pages in this report, 189 pages are devoted to detailed geologic and mineralogic descriptions of approximately 55 copper-uranium occurrences. Thirty-five of these occurrences are previously undescribed; several others had been "lost" and locations are provided. For each occurrence, the exact location is indicated on a 1:24,000-scale map, and by latitude and longitude, bearing and distance from several points, and elevation. A description of each observed major, minor, and trace mineral is provided for each occurrence. The highlight of the report is an 8-page section with 32 full-color photographs of minerals and fossils from the district. The color section includes photos of such rare minerals as chalcophyllite, cuprosklodowskite, metazeunerite, tyrolite, and widenmannite. The report also contains 89 black-and-white figures, most of which are locality and specimen photographs. Appendix 1 contains a list of minerals identified in the area.

For the economic geologist, quantitative analyses for U_3O_8, Cu, As, and Pb have been obtained for 77 channel and dump composite samples. An apparent variation in composition of these red-bed occurrences with stratigraphic position within the Devonian Catskill Formation is noted.

Mineral Resource Report 80 can be obtained from the State Book Store, Room G-56, South Office Building, Harrisburg, for $17.65 plus $1.06 tax. If ordering by mail, enclose a check payable to the Commonwealth of Pennsylvania for $18.30 (plus $1.10 tax for PA residents) and send to the State Book Store, P. O. Box 1365, Harrisbug, PA 17105.



PROFESSOR LAWRENCE WHITCOMB, 1900-1984

Dr. Lawrence Whitcomb, Associate Professor Emeritus of Geology at Lehigh University, died on September 6, 1984 at the age of 84. He was an outstanding teacher and a distinguished expert of Paleozoic stratigraphy and paleontology. A graduate of Brown and Princeton Universities, he served on the Lehigh faculty from 1930 until his retirement in 1965.

Widely recognized for his sophisticated research and interpretations, Professor Whitcomb insisted on teaching one or more beginning courses each semister to inspire and establish contact with the students. For his skill and dedication as a teacher, he was awarded the Lindback Distinguished Teaching Award in 1964.

Professor Whitcomb authored 24 papers, including several on the stratigraphy and paleontology of Pennsylvania. The Pennsylvania Survey had high regard for Professor Whitcomb and his research work; in 1932 we published his "Correlation of Ordovician Limestone at Salona, Clinton County" as our General Geology Bulletin G 5.

We recognize the passing of Dr. Lawrence Whitcomb with great sadness.

Announcing—

York Rock & Mineral Show/Delaware Valley Fossil Fair

The York Rock & Mineral Club will hold its Sixteenth Annual Mineral and Gem Show on Saturday, April 13, and Sunday April 14, 1985, at the Alert Fire Company Hall, Emigsville (Rt. 181 north of York). Show hours are 10 a.m. to 7 p.m. on April 13 and 10 a.m. to 5 p.m. on April 14. Admission is $1.00 per person. For further information contact Show Chairman, Ken Kauffman, 747 Florida Avenue, York, PA 17404.

The Delaware Valley Paleontological Society will host its sixth annual Fossil Fair at the Academy of Natural Sciences in Philadelphia on Saturday, March 9 and Sunday, March 10, from 10 a.m. to 4 p.m. This year's Fossil Fair will include numerous exhibits, a fossil sales booth, refreshments, and educational and children's activities. The Pennsylvania Geological Survey will host a booth with books and information on collecting fossils in Pennsylvania. Admission to the Fair is free with admission to the Academy of Natural Sciences.

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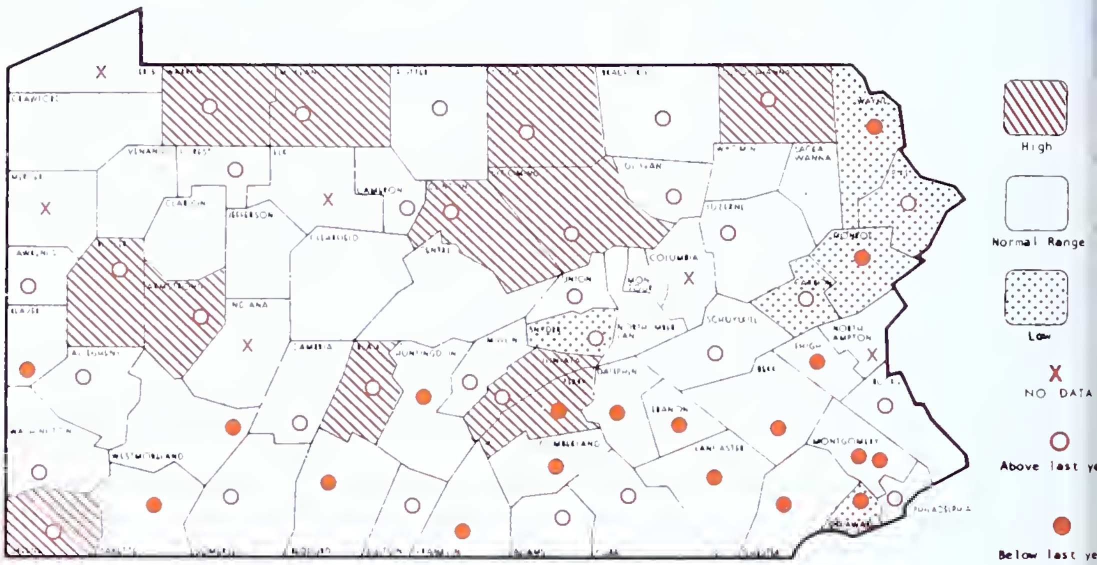

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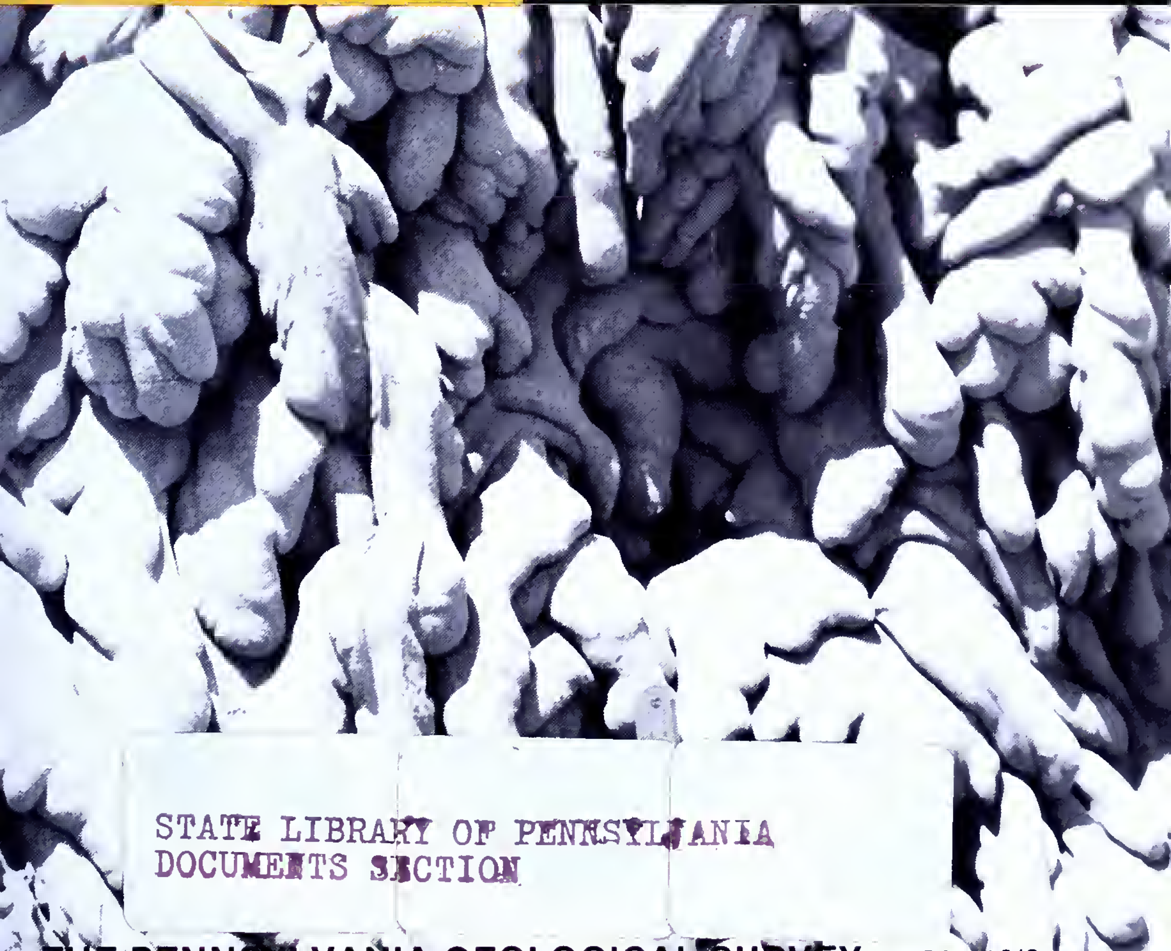

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THE PENNSYLVANIA GEOLOGICAL SURVEY VOL. 16/2

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ON THE COVER: Nature's pattern; sandflows in cut-bank of glacial sand deposit, near Lake Wallenpaupack, central Pike County. Photo courtesy of Linda M. Crum.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

VOL. 16, NO. 2 **APRIL, 1985**

FROM THE DESK OF THE STATE GEOLOGIST

ACHES OF AN AILING MINERAL INDUSTRY

By all standards the national mining industry is depressed, particularly the metal mining industry. This in the face of a strong recuperating national economy which is traditionally a heavy consumer of metallic minerals. This has had repercussions in Pennsylvania which in recent years has seen the closing of its last two major metal mines, both with large ore reserves remaining in the ground. The depressed mining industry is also keeping exploration geologists from pursuing a variety of promising mineral prospects in our state.

Why the American mining depression? Largely because the mineral industry has turned to foreign sources which are providing high-grade ores at much lower operating costs than possible in the U.S. This dependence on foreign ores has a mixed impact on the U.S. On one hand the U.S. consumer has the benefit of lower cost mineral resources for its manufacturing needs. On the other hand American capital is going abroad while we have a truly depressed domestic mining community, with thousands of unemployed miners and related support workers.

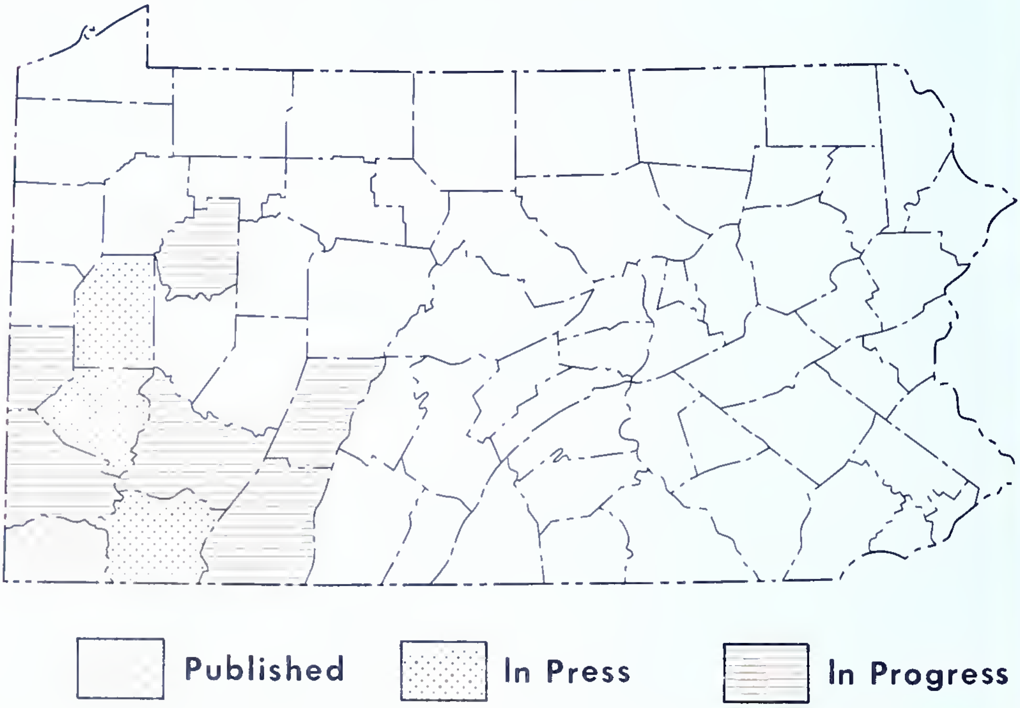
Of particular concern is our dependence on resources in foreign countries whose stability and reliability may be subject to sudden change. Unlike manufactured items (such as autos) which we could readily replace if cut off from foreign sources, it would take many years to "crank up" our own mineral deposits if we were denied critical foreign sources.

Thus, for the sake of national security our country needs a program of planned mineral self-sufficiency, at least on a standby basis for potential times of crisis. Assuring the domestic availability of essential mineral needs would constitute a truly strategic weapon.

Arthur A. Socolow

Greene County Publication kicks off New Series of Coal Resource Reports

The Bureau of Topographic and Geologic Survey has unveiled a new series of coal-resource reports with the recent publication of *Coal Resources of Greene County, Pennsylvania—Part 1. Coal Crop Lines, Mined Out Areas, and Structure Contours*. The report, compiled by staff geologists Clifford H. Dodge and Albert D. Glover, is one of many that will be published over the next few years for the major bituminous-coal-producing counties in western Pennsylvania. Coal-resource reports will be issued in several parts for each of these counties. Part 1 for each county will contain maps showing coal crop lines, surface and deep mined-out areas, and structure contours; other parts will contain tabular information on the coal resources of the counties and computer-generated thickness and quality maps of the principal (principally mined) coals. The maps will show sulfur trends, heat value, ash content, and trace-element trends for each coal.



Part 1 of the Greene County report contains two kinds of coal maps. First, for each of the principal coal seams in each 7½-minute topographic quadrangle in the county, there is a map showing (1) the coal outcrop (crop line); (2) areas where the coal is known to be absent because of seam discontinuities; and (3) the extent of all known strip and deep mining up to the time of compilation. Second, for each quadrangle, there is a composite coal-crop map that includes structure contours and fold axes. If none of the principal coals has been mined or crops out in a particular quadrangle, only the second kind of map is presented. The two-color maps contain information on sources of published and unpublished data, map reliability, map symbols, map scale (approximately 1:62,500), structure contour intervals and datums, and names of fold axes. This report is published as a package of 8½- by 11-inch, pre-punched sheets that will fit standard three-ring binders for convenient use in the office and field.

Anyone involved in planning coal-exploration programs, land acquisition, land use planning, and environmental protection should find this report to be of considerable use. Comments on this new series of publications are invited.

This 67-page publication is designated as Mineral Resource Report 86, Part 1, and is available from the State Book Store, P. O. Box 1365, Harrisburg, PA 17105. The price is $5.75 by mail and $5.00 over the counter (plus 6% sales tax for Pennsylvania residents). A check made payable to *Commonwealth of Pennsylvania* must accompany the order.

Similar reports on Allegheny and Butler County will be published this summer and will be announced in a forthcoming issue of *Pennsylvania Geology*.

New Pennsylvania Mineralogy Book

The Mineralogical Society of Pennsylvania has announced publication of a new book, *Highlights on the Life of Charles M. Wheatley*, by F. Harold Evans. This is a 48-page volume of the "famous Chester County, Pennsylvania, mine operator, mineralogist, palaeontologist, naturalist, conchologist, and copper metallurgist" with *Forward* and *Appendix* by geologist Dr. Allen V. Heyl. In addition to the biographical story, there are portraits of Wheatley, sketches of old mines as well as maps and cross-sections, extensive references (both historical and geological), and data on several mines, including up-to-date mineral lists. The cover of the 8½- by 11-inch paperback is the blue-green associated with many copper minerals.

The co-sponsoring Mineralogical Society is distributing the book. Write the Society c/o Dr. Arnold Fainberg, 598 N. Prince Frederick St., King of Prussia, PA 19406 ($2.50 ppd. for members and $4.50 ppd. for others).

PETROLOGY AND RESERVOIR CHARACTERISTICS OF THE LOWER SILURIAN MEDINA GROUP SANDSTONES

Exploration and development of the Lower Silurian Medina Group clastics presently dominates deep drilling activity along the northwestern flank of the central Appalachian basin. In Pennsylvania, Medina production is from very fine- to medium-grained sandstones that form low-permeability and low-pressure reservoirs across five counties in the northwest corner of the state. Aggressive development programs in the Athens and Geneva gas fields of Crawford County, Pennsylvania, have provided substantial amounts of geological and engineering data in the way of cores, samples and geochemical and geophysical logs. This information is integrated and interpreted in a new report published by the Pennsylvania Geological Survey entitled *Petrology and Reservoir Characteristics of the Lower Silurian Medina Group Sandstones, Athens and Geneva Fields, Crawford County, Pennsylvania.*

This investigation of the Medina Group reservoir sandstones in the Athens and Geneva gas fields was conducted for four specific purposes. The first was to describe the vertical and lateral distribution of depositional environments in the subsurface and define the relationship between these environments and the porosity and permeability of the sandstones. The second was to outline the diagenetic history of the sandstones with an emphasis on the postdepositional occlusion and enhancement of porosity. The third was to determine the various effects that detrital and diagenetic minerals have on reservoir quality and geophysical-log response, and the fourth was to describe the sensitivity of the Medina Group sandstones to drilling, completion, and stimulation fluids of different compositions.

This report is liberally illustrated with thin section and scanning electron microscope photomicrographs which clearly document the various kinds of grains, cements, clays and pores that make up the Medina reservoir rocks. Various aspects of geophysical log interpretation problems are portrayed graphically. The results of two core analyses and one hundred and fifty-six geophysical log analyses are listed. This report should be of extensive use to all who are engaged in hydrocarbon exploration, development, and research in Pennsylvania and adjacent states.

Petrology and Reservoir Characteristics of the Lower Silurian Medina Group Sandstones, Athens and Geneva Fields, Crawford County, Penn-

sylvania, Mineral Resource Report 85, was authored by C. D. Laughrey of the Pennsylvania Geological Survey. It is available at the State Book Store, P. O. Box 1365, Harrisburg, PA 17105. The price is $5.65 (plus 6% tax for Pennsylvania residents). Enclose check payable to *Commonwealth of Pennsylvania.*

1985 Field Conference of Pennsylvania Geologists

The 1985 Field Conference of Pennsylvania Geologists will be the 50th conference conducted. To celebrate the golden jubilee of our conference, we plan special evening programs in addition to four one-day field trips which will be led by our hosts, The Pennsylvania State University, during the two-day period.

To prepare for one of these programs, we seek photographs and slides of prior Field Conferences, particularly with identified people. Anyone who has any photographs and slides that they would care to share with us will receive our thanks. If you would send them to us, we will have them duplicated and the originals will be returned to you.

Help us make this a celebration worthy of the 50 field trips which have greatly furthered our understanding of the geology of Pennsylvania.

And plan now to attend the 50th Field Conference October 3, 4, and 5, 1985. If you have not attended either of our last two field conferences and wish to receive notice of the meeting and registration information, write to Field Conference of Pennsylvania Geologists, c/o The Pennsylvania Geological Survey, P.O. Box 2357, Harrisburg, Pennsylvania 17120.

GEOLOGY TEACHERS TO MEET

The Eastern Section of the National Association of Geology Teachers will meet May 24–26 in Toronto, Canada. For details contact Robert Lord, Geography and Geology Department, Bramalea Secondary School, 510 Balmoral Drive, Brampton, Ontario, Canada L6T 1W4.

WARNER COMPANY'S BELLEFONTE OPERATION

by S. W. Berkheiser, Jr.
Pennsylvania Geological Survey

The Bellefonte area contains one of the purest high-calcium limestone deposits (Valentine Member of the Linden Hall Formation) in the Commonwealth and is an important lime-producing district. Since before the turn of the century, Warner Company and its predecessor, American Lime and Stone Co., have produced high-calcium products from quarries and later (1920's) from underground mines in this area (Figure 1). Warner Company was the first to use a rotary-kiln for calcining limestone in the Nittany Valley. Starting in the 1920's they were pioneers in developing this technology, which greatly increased production rates compared to the more common shaft kilns of that time.

Geology and Mining

The Valentine Member of the Linden Hall Formation, which is equivalent to the Benner Formation, is characterized as a high-calcium

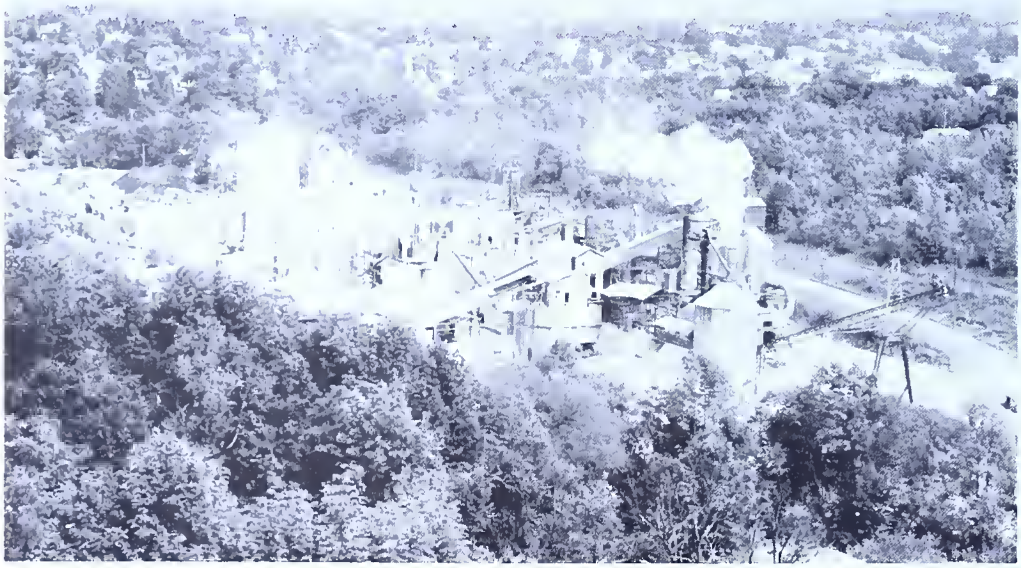


Figure 1. Overview of Warner Company's Bellefonte operation looking to the southeast with Bellefonte in the background.

(>96% $CaCO_3$), medium-dark-gray, fine-grained, thick-bedded limestone commonly containing 1- to 2-mm sized calcite crystals. At the Bell-Mine, the ore deposit consists of almost pure calcite ($CaCO_3$) present as the Valentine limestone. It is exposed on both the north and south sides of Nittany Valley, forming an asymmetrical, breached anticline with bedding dips on the limbs of about 80°NW and 25°SE respectively (Berg and others, 1980, and Miller, 1934). Thicknesses of this high-calcium interval are variable, but best developed in the Bellefonte area where the steeply dipping north limb ranges from about 45 feet to 60 feet and the more gently dipping south limb commonly varies in thickness from between about 60 feet to 90 feet. Presently the kiln feed (plus 1/4"-sized limestone) for this operation comes from two sources.

The first source, the Bell-Mine, has been a traditional underground source for the purest end-products produced and is located on the steeply north dipping north limb. The shaft is located about 1 mile due west of Bellefonte (Figure 2). Here a "two-sub-level open stope" mining method developed to the 960-foot level extracts about 80% of the

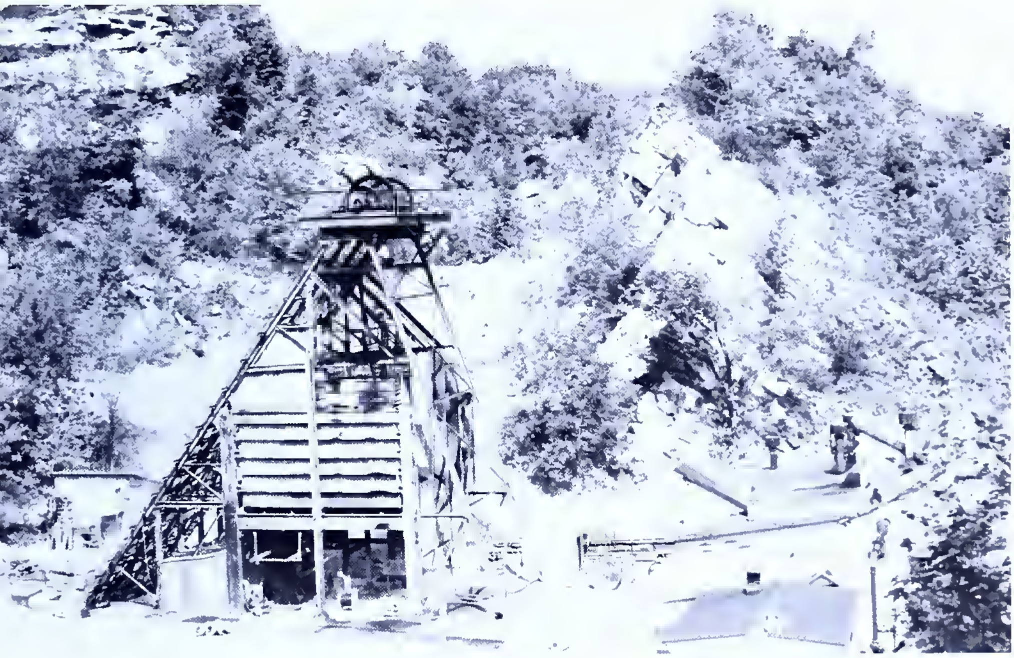


Figure 2. Main service shaft and headframe of the Bell-Mine. Notice evidence of surface mining the Valentine Member of the Linden Hall Formation (Benner Formation) in the background. Shaft is sited on the less pure Valley View Member of the Linden Hall Formation.

available Valentine ore (Figure 3). The main service shaft is nearly vertical and was sunk in the underlying, less pure Valley View limestone member near the footwall of the steeply dipping ore body. The main haulage of this lower level is developed near the hanging wall in Valentine ore. These lower workings have been developed along strike to the northeast for about 1 mile and to the southwest for almost 2 miles.

Individual stopes are about 300 feet high, containing an undercut and two sublevels. These stopes are about 335 feet in length (excluding 50-foot-thick end pillars) with three raises driven to the second sublevel. A 60-foot-thick crown pillar is left at the top of each stope. Mining progresses by making an undercut near the haulage level, which leaves a block of ore to protect the main haulage and direct subsequent stoped ore into 4 loading alcoves (Figure 4). Stoping is accomplished by radially drilling and blasting ore from the two sublevels. Primary crushing is completed underground. Haulage to the crusher is by rail. Drilling and blasting are carried out on the day shift, whereas hauling and crushing are accomplished on the second shift and "grave yard" shift; this produces about 1440 tons per day kiln feed to a surface surge pile.

The second source, the Gentzel Quarry located about 3 miles southwest of Bellefonte, was recently developed on the south limb of this anticlinal structure, where dips are less and the Valentine is slightly thicker. This quarry provides supplemental kiln feed and products.

Manufacturing

High-calcium pebble and ground lime (CaO) are the principal products manufactured. Two bituminous, coal-fired, rotary-kilns can produce about 900 tons of quicklime per day. This is a significant contrast in both production and labor to the older vertical-batch and draw-type kilns (Berkheiser and Hoff, 1983). The ratio of limestone to coal to make lime in the rotary kilns is about 3:1, whereas the older batch type kilns commonly required a ratio of about 5:1. Warner's Bellefonte operation requires about 275 to 300 tons of coal per day, which is pulverized on site.

Other high-quality products include hydrated lime ($Ca(OH)_2$), glass-stone (provides chemical durability to glass), and pulverized limestone. The quicklime typically contains about 95% CaO, <1% MgO, and <2% SiO_2, plus insolubles. Typical analyses of the limestone products contain about 98% $CaCO_3$, 1% $MgCO_3$, 0.1 to 0.2% Fe_2O_3 and generally <2% SiO_2, plus insolubles. About 500,000 tons of limestone are mined each year.

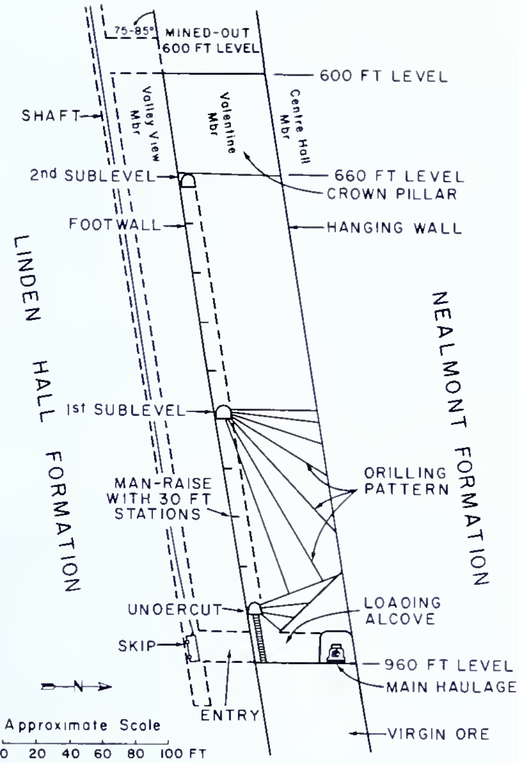


Figure 3. Generalized cross-section and sketch illustrating the "two-sublevel open-slope" mining method. Modified from company illustrations.

Figure 4. Mine Superintendent, Tom Leonard, in a loading alcove on the 960-foot level; the footwall is in the background.

Marketing

Greater than 40% of the lime produced is consumed by the steel industry. Environmental uses such as sewage treatment, stack gas scrubbers (reduces acid emissions), and water treatment are other major markets which have been steadily increasing. Agricultural products, fluxstone, and coal mine rock dust (suppresses coal dust explosions) are other rock products produced at this plant.

The majority of these products are transported to their respective markets by truck. In general, a 200-mile radius encompasses most of their customers; however, they do service clients as far away as Illinois and California.

Summary

Warner Company holds additional high-calcium reserves and resources in the Nittany Valley which insure a future supply of quality lime and limestone products in Pennsylvania. Furthermore, a real concern for mitigating this industry's impact on the surrounding environment is shown by the numerous steps they have taken, such as sophisticated dust-suppression loading facilities, wet scrubbing of the kiln gases, and developing settling ponds where acidic solutions are added to lower the pH before discharge. Warner's pioneering spirit continues, which helps make Pennsylvania a leading high-quality lime producing state in the U.S.

We thank Warner Company, and in particular Mr. Robert Woodring and Tom Leonard, for their time and cooperation.

References

Berg, T. M., and others (1980), *Geologic map of Pennsylvania*, Pennsylvania Geological Survey, 4th ser., Map 1.

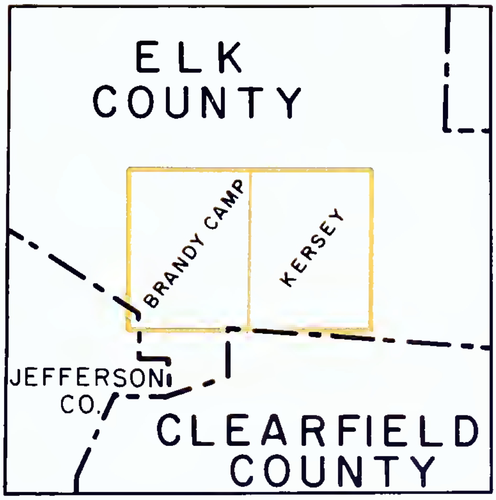
Berkheiser, S. W., Jr., and Hoff, D. T. (1983), *The Arthur L. Long lime kiln, an active record of yesteryear*, Pennsylvania Geology, v. 14, no. 5, p. 9–15.

Miller, B. L. (1934), *Limestones of Pennsylvania*, Pennsylvania Geological Survey, 4th ser., Mineral Resource Report 20, p. 282–291.

FRANKLIN COUNTY ROCK & MINERAL CLUB

The Franklin County Rock and Mineral Club will hold its Eighth Annual Jewelry and Mineral Show at the Chambersburg Middle School, McKinley Street and Stouffer Avenue, Chambersburg, PA. Hours: May 4—10:00 a.m. to 7:00 p.m. and May 5—11:00 a.m. to 5:00 p.m. For further information contact Show Chairwoman Pat Hoyer, 8810 Rowe Run Road, Shippensburg, PA 17257. Phone 717–532–6058.

GEOLOGIC MAPPING BEGINS IN SOUTHERN ELK COUNTY



The Bureau of Topographic and Geologic Survey has recently initiated a detailed geologic mapping project of the Brandy Camp and Kersey 7½-minute quadrangles in southern Elk County, north-central Pennsylvania. Little geologic mapping has been done in Elk County since the 1880's, and detailed information is needed for efficient mineral-resource development, land use planning, and environmental protection. Elk County is rich in natural resources including bituminous coal, oil and gas, high-calcium limestone, sandstone, clay and clay shale, and sand and gravel.

The results of this study will be published as an Atlas Report consisting of a detailed (scale 1:24,000), full-color geologic map of the bedrock (which encompasses sedimentary rocks of Late Devonian to Pennsylvanian age) and unconsolidated surficial deposits of the two quadrangles. Included with the geologic maps will be a columnar section, a cross-section, a triple-column legend denoting the mineral-resource, groundwater, and engineering characteristics of the various geologic formations, and a table of resource calculations of the major coal seams. A short text will also be included.

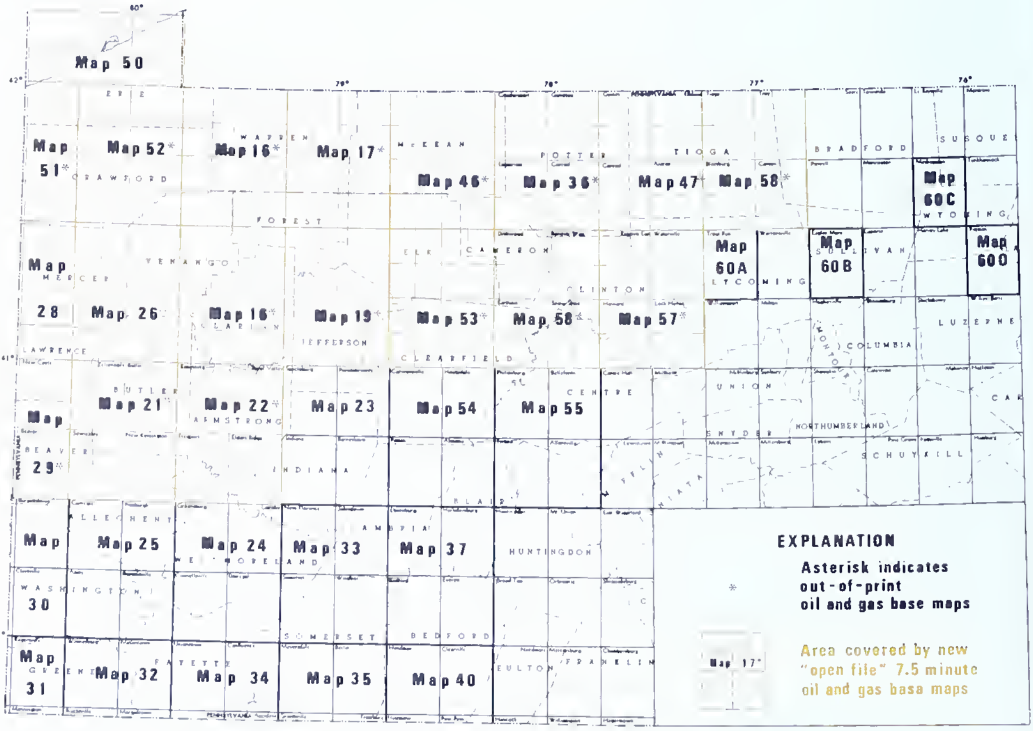
This atlas should be of considerable interest and use to the coal industry, local officials, engineers, conservationists, and residents of the area.

Geologic mapping of the Brandy Camp and Kersey quadrangles will be carried out by staff geologist Clifford H. Dodge. Field work will begin this spring, and the project will be completed in the autumn of 1987.

New Oil and Gas Base Maps

The Pennsylvania Geological Survey, Oil and Gas Geology Division, is making available to the public a new series of oil and gas base maps through our "open file" procedure. Each new base map is a "blueline" reproduction of a standard U.S. Geological Survey 7.5-minute (1 inch equals 2,000 feet) topographic map on which is shown the locations and identifying numbers of oil, gas, and service wells in the represented area (see the accompanying index map). The topographic portion of each map is subdued to let the well symbols stand out, but is still legible on a blueline reproduction.

The new 7.5-minute base maps are designed to replace, rather than supplement, the 15-minute series of oil and gas base maps sold through the State Book Store. The maps of the now out-of-print, 15-minute series were generally some of the State Book Store's better selling items, but the scale of the maps, the lack of topographic and cultural information, and the crowding of symbols from postings of new information led to our decision to replace them with a more useful and appropriate series. Because the new maps are the same scale as the Division's work maps, the 7.5-minute series will be easier to update on a regular basis.



Old base maps now declared out-of-print are Maps 16, 17, 18, 19, 21, 22, 26, 28, 29, 36, 46, 47, 50, 51, 52, 53, 56, 57, and 58.

With the change in mapping scales come certain inevitable changes in the types of information shown by the maps. The now out-of-print 15-minute base maps were essentially blank of all geographic information other than a 5-minute grid, the quadrangle names, county boundaries, and some major rivers and towns as background. The 7.5-minute maps, being reproductions of standard U.S. Geological Survey topographic maps, show all of the geographic information including grids, topography, streams, roads, etc. The now out-of-print 15-minute map series showed well symbols, Survey file numbers, availability of geophysical log and sample data on open file, and the outlines of fields and pools. The new 7.5-minute map series show only the well symbols and identifying numbers (typically the permit or project numbers). Other information, such as total depths, elevations, log and sample symbols, and field outlines are not put on the new maps because of anticipated lack of space and the need to protect the original from constant erasure with addition of new information; this information may henceforth be obtained by contacting the Oil and Gas Geology Division at the Bureau's Pittsburgh Office.

The index map accompanying this announcement indicates the locations of all newly available maps and the now out-of-print 15-minute base maps they replace. Announcements concerning the availability of additional 7.5-minute maps (and the subsequent out-of-print status of the corresponding 15-minute base maps they replace) will be made in future issues of "Pennsylvania Geology" and in the Survey's annual report of oil and gas developments in Pennsylvania.

When requesting maps please provide the 7.5-minute topographic map name of each map desired. To determine map names refer to the "Pennsylvania Index to Topographic and Other Map Coverage" published by the U.S. Geological Survey and available free of charge by writing to our Bureau offices or from Branch of Distribution, U.S.G.S., 1200 S. Eads St., Arlington, VA 22202.

For any further information, you may contact the Pennsylvania Geological Survey, Oil and Gas Geology Division, 7th Floor Highland Building, 121 S. Highland Avenue, Pittsburgh, PA 15206, (412) 665–2155.

New Fossil Collecting Locality in Columbia County

by John E. Ryan
Delaware Valley Paleontological Society

Superb Middle Devonian fossils may be collected at a road cut on the northwest side of Pa. Route 254, just west of the center of Millville in Columbia County (Figure 1). The road cut is the second of three cuts which occur along Route 254 between 0.3 and 0.65 mile southwest of its intersection with Pa. Route 42 (41°06′58″N/76°32′17′W, Millville quadrangle). By far the best and most numerous fossils occur at this second exposure, although a few fossils may be found in the other two road cuts.

Fossils are abundant and accessible at this exposure. There is ample parking for several vehicles just beyond the southwest end of the cut. Because the outcrop is only 6 feet from the edge of a 3-lane highway, this site is not suitable for large groups. EXTREME CAUTION MUST BE EXERCISED AT ALL TIMES. Collectors should take special pains not to disturb adjacent private property or to damage the exposure. Courteous behavior by collectors should ensure that this locality remains open to the public.

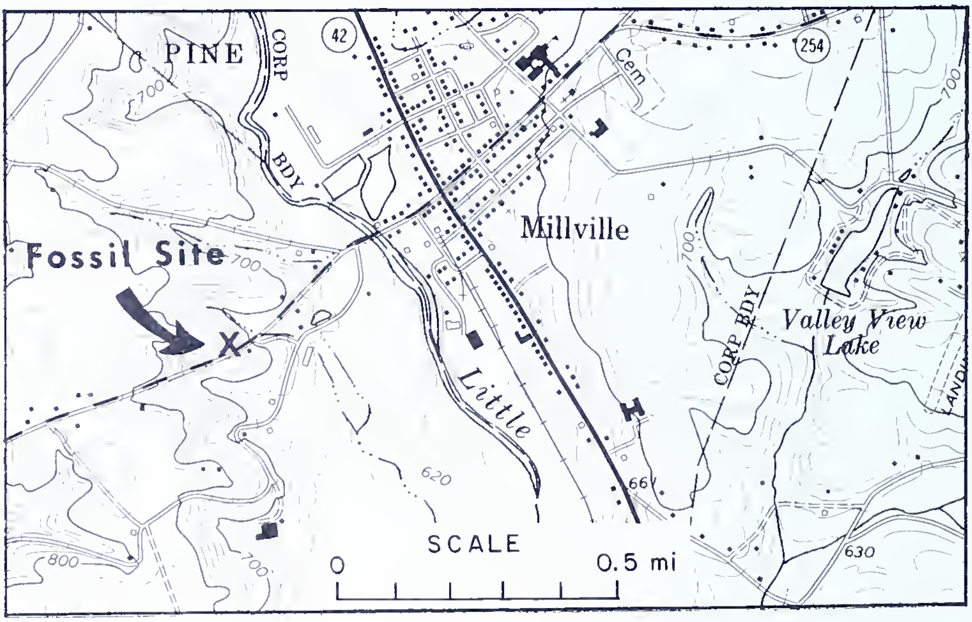


Figure 1. Location map.

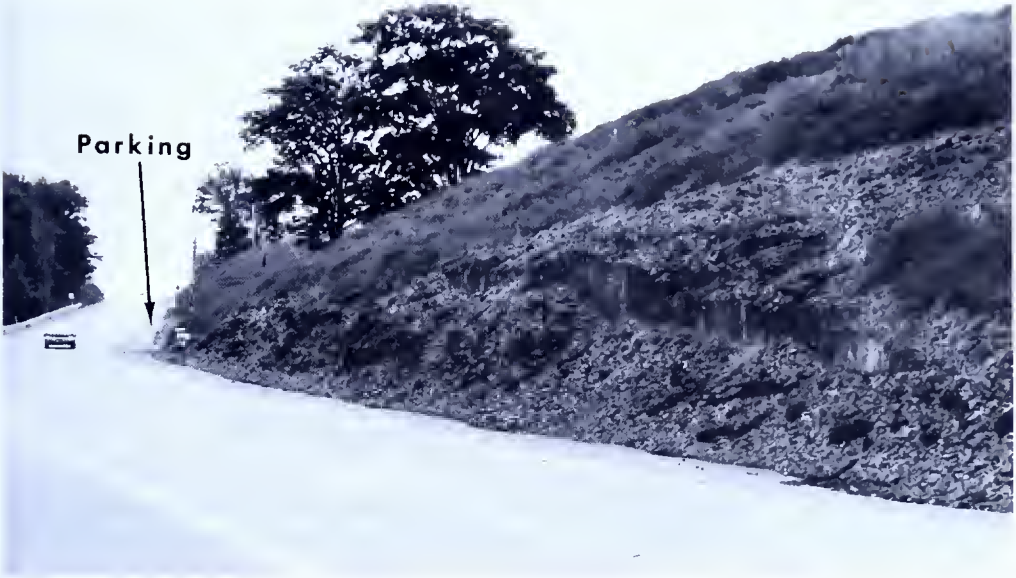


Figure 2. Fossiliferous Mahantango shale exposed at Millville fossil site. (Photo by John H. Way.)

The rock layers at the center exposure are medium-dark-gray shales and siltstones belonging to the upper part of the lower member of the Mahantango Formation (Way, in preparation) (Figure 2). These layers incline slightly to the north and east, although the bedding cross-section at this exposure is fairly level. Fossils are most common in a zone of shales several feet thick that runs the length of the exposure. Embedded in the shales are calcareous nodules of various unusual shapes, the smaller of which also contain fossils. (While these nodules are inorganic, some may at first be confused with fossil remains, especially with fragments of straight cephalopods.) The fossils are preserved as molds and casts, mineralized remains, and occasional original shell material. Preservation surpasses the norm for the Mahantango, and many specimens retain the finest detail.

Spiriferid brachiopods, particularly the genus *Pustulatia,* are the most common fossils. This locality is most noteworthy, however, for the occasional complete specimens of the trilobites *Greenops* and *Phacops* which occur throughout the fossiliferous zone. These trilobite fossils show excellent preservation, and some specimens approach museum quality. Pelecypods and gastropods also are common, with the gastropod *Palaeozygopleura* occurring frequently in the upper part of the fossiliferous zone.

The following fossils have been identified from this locality:

CORALS
Heterophrentis (P)

BRACHIOPODS
Lingula (P)
Craniops (R)
Orbiculoidea (R)
Rhipidomella (U)
Tropidoleptus (U)
Douvillina (P)
Longispina (P)
Athyris (C)
Pustulatia (A)
Mucrospirifer (C)
Spinocyrtia (C)
Mediospirifer (C)

BIVALVES
Palaeoneilo (C)
Phestia (P)
Aviculopecten (P)
Modiomorpha (P)
Cypricardella (P)

BRYOZOANS
Sulcoretopora (P)

GASTROPODS
Bellerophon (R)
Holopea (P)
Palaeozygopleura (C)

CEPHALOPODS
Michelinoceras (P)
Spyroceras (P)
Unidentified ammonoid (R)

TRILOBITES
Phacops (C)
Greenops (C)

CRINOIDS
Columnals (P)

FISH
Placoderm scales (R)

Letters denote the frequency with which the fossils are found. A = abundant; C = common; P = present; U = uncommon; R = rare.

Illustrations of these fossils can be found in Ellison (1965) and Hoskins and others (1983).

The shales and siltstones exposed along Route 254 were deposited in a warm, shallow sea some 387 million years ago, probably during a period of marine transgression. Both the fine grain size and the local traces of calcium carbonate suggest that the sediments were deposited at some distance from the shoreline. The occurrence of the brachiopod *Lingula* shows that the water depth was quite shallow, however, probably no greater than 60 feet (see Faill and Wells, 1974, p. 49).

The many articulated shells and the absence of fossils which exhibit breakage or wear due to transport indicate that the Millville fauna is a life assemblage, and that the organisms lived in a quiet-water environment. Although the presence of small amounts of pyrite (iron sulfide) suggests that the bottom waters tended to stagnate, many types of invertebrate organisms were able to proliferate on the sea floor despite the absence of strong circulating currents.

The author wishes to thank Jon D. Inners and John H. Way, of the Pennsylvania Geological Survey for their advice and assistance in the preparation of this article. Emily B. Giffin, formerly with the Pennsylvania Historical and Museum Commission, provided help during the initial field investigation.

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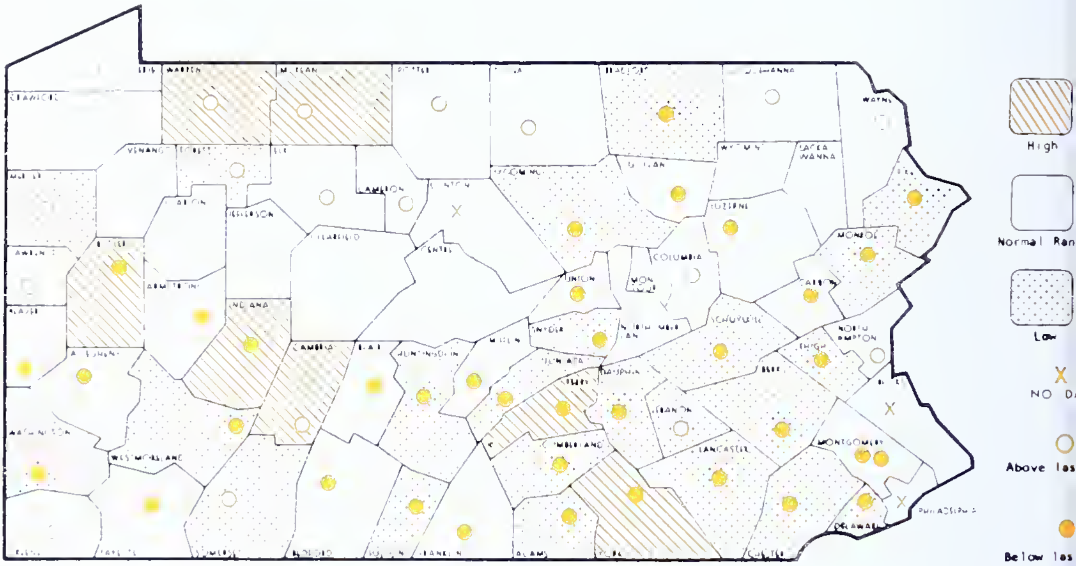

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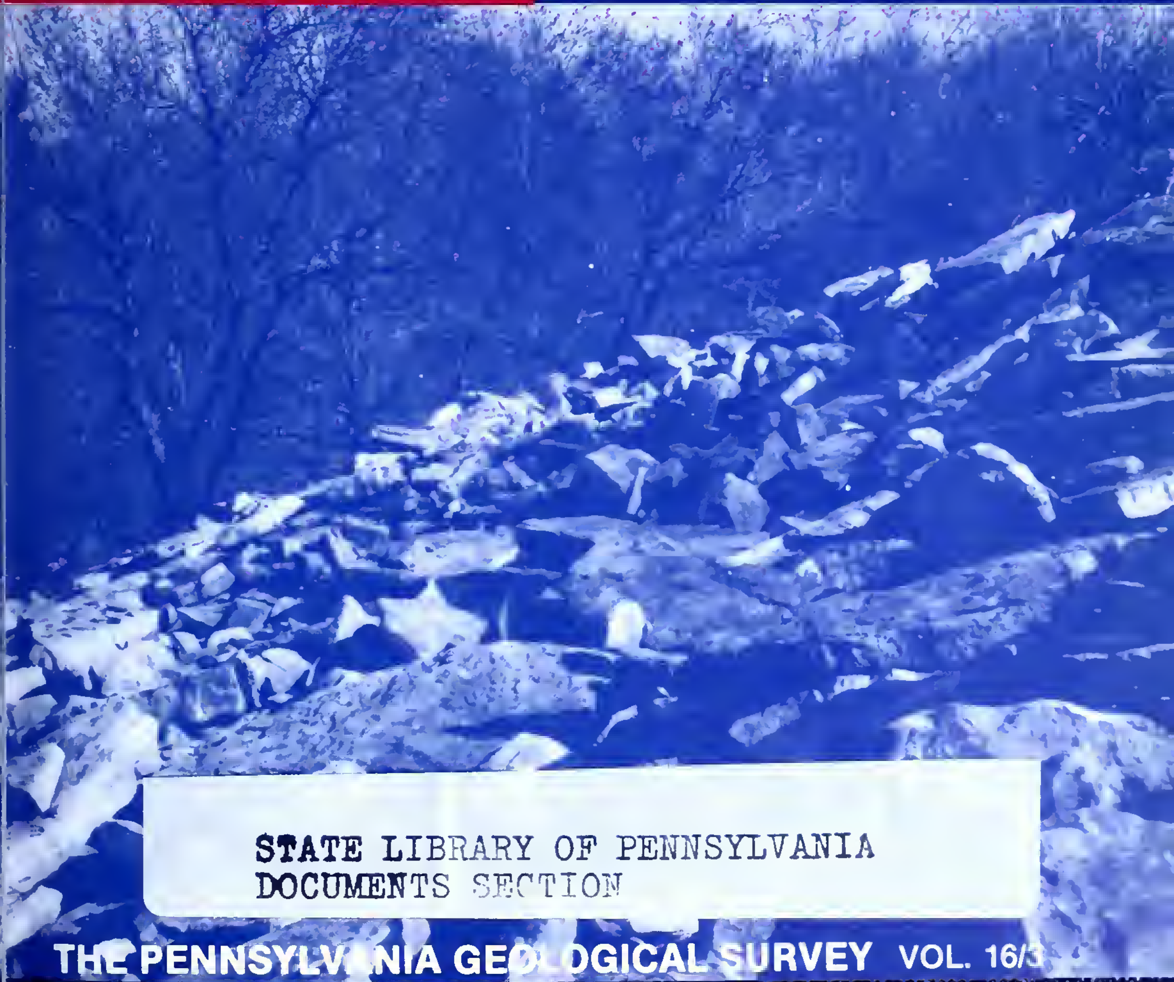

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ON THE COVER: A talus slope composed of blocks of the Silurian-age Tuscarora quartzite, exposed on the north slope of Blue Mountain at Waggoners Gap, Route 74, Perry County. Photo courtesy of W. D. Sevon.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

VOL. 16, NO. 3 **JUNE, 1985**

FROM THE DESK
OF THE
STATE GEOLOGIST

A GEOLOGIST'S WORK IS NEVER DONE

Once upon a time, not too many years ago, when labs in the scientific community were able to do analyses which revealed minor constituents in quantities as low as one one-thousandth (.001) of a percent, we were very comfortable that such measurements showed up important contaminants or problem constituents. But analytical techniques and instruments have evolved to give us measurements and accuracies to such levels as one part per billion (or one ten-millionth of a percent). As a result, we have recognized trace elements and minor constituents we previously were not aware of, some of which present contamination or health problems which call for remedial actions.

This revolution in analytical techniques has presented new investigative responsibilities upon our geologic community, as well as the more publicized realm of biological science. For example, what minor constituents in clays affect their utility as raw material for ceramic products? Or what trace elements in a particular bed of coal might produce harmful stack emissions? Where is there a minor, noneconomic occurrence of uranium minerals which may yield threatening quantities of radon? And what problematic, minute constituents are dissolved in our groundwater as it passes through our various types of rock formations?

Analytical progress has thus imposed new obligations and challenges upon geologists for accurate data collection and measurements in areas and upon resources where we once thought we had a fairly complete grasp of the geologic environment. Utilizing new equipment and new techniques, we have to revisit, reexamine, and re-sample many geologic situations.

Geology has in recent years received some publicity for innovative, new principles in continental deformation and mountain building (plate tectonics), as well as oceanographic processes relating to formation of mineral deposits. To those new concepts of megaprocesses which have caused us to re-think the origins of our geological "backyard," we should also recognize that the details of analytical progress, much less publicized, have imposed a wide array of new duties upon geologists. Much as we have accomplished over the years, much more detailed work now faces us.

Arthur G. Socolow

Refractory Dolomite Production in Southeastern Pennsylvania—
THE J. E. BAKER CO.

by David A. Hopkins
J. E. Baker Company

The J. E. Baker Company has been in the quarry business since 1889. In the early 1900's, the Baker Company became the first to produce a "roasted" (sintered) dolomite for use as a refractory product by the steel industry. J. E. Baker Company has produced dolomite at numerous quarries in Pennsylvania, including the Billmeyer quarry near Bainbridge, Lancaster County which operated from 1896 until 1962 (Figure 1). Two quarries were also operated directly across the Susquehanna River at Saginaw in York County, from 1902 until 1942. World War I saw increased demand for refractory products and the temporary production of dolomite from the Chickies quarry near Marietta in Lancaster County.

Since the mid-1950's the Baker Company has quarried high-purity dolomite west of the city of York in southeastern Pennsylvania (Figure 2). The associated plant and 300-foot-long rotary kiln were commissioned in 1952 and an additional rotary kiln was added in 1959.

The Middle Cambrian Ledger Formation is the quarry rock from which the high-purity dolomite (generally less than 1% total impurities other than carbonates) is extracted. It is part of the Cambro-Ordovician carbonate sequence that is extensively exploited in the York-Hanover portion of the Conestoga Valley. The Ledger Formation at this site is characterized as a pure, light-gray mottled with dark gray, coarsely crystalline, low porosity dolomite. Locally the dolomite contains oöliths suggesting recrystallization of a rather pure shallow water limestone deposit. Stose and Jonas (1939) estimated the Ledger to be about 1000 feet thick in the general area. Structural complexity in the quarry is masked by the lack of identifiable bedding and extensive faulting. Paleo-karst features within one area of the quarry are attributed to the nearness of the southern border of the Mesozoic Basin.

The geologic complexity encountered through mining has led to the evolution of a very intensive quality-control program that insures proper quality of the various products manufactured (see Hopkins,

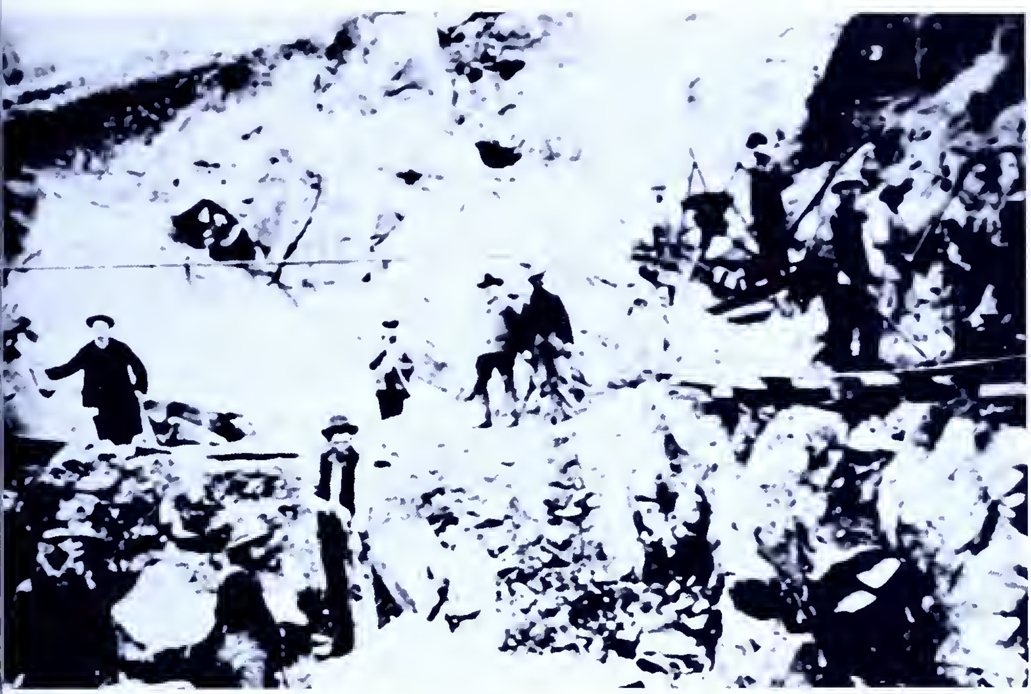

Figure 1. Photograph of the J. E. Baker Company's now-abandoned Billmeyer Quarry near the turn of the century showing the process of drilling dolomite.

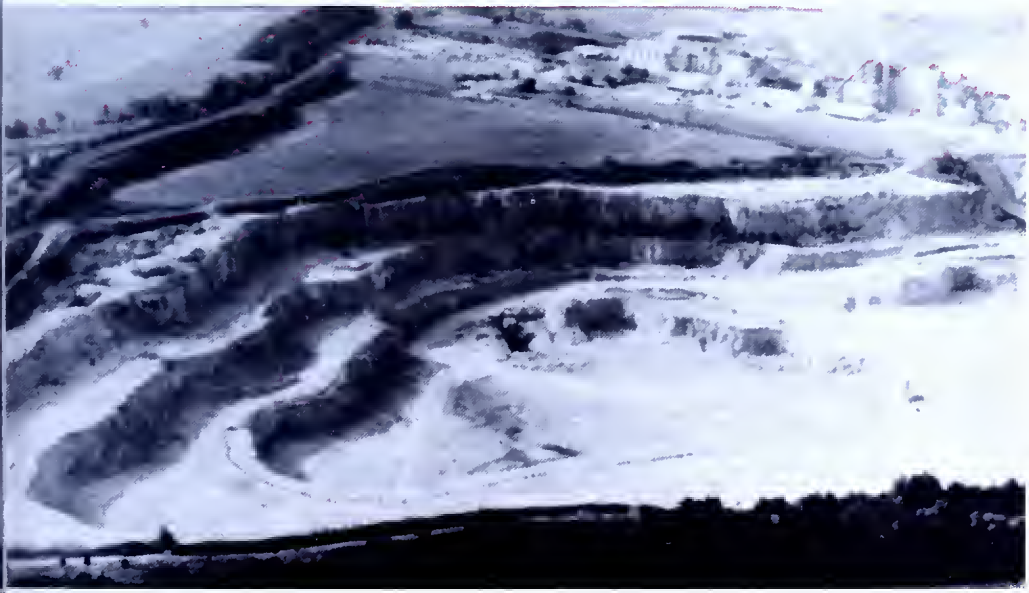

Figure 2. A southwest-looking view of the J. E. Baker Company's active quarry and plant. Quarry benches are about 50 feet in height. A sense of scale can be achieved by comparing the size of the production drill located on the 3rd level, bottom right of photograph.

in press). The program begins with close spaced diamond core drilling, proceeds through selective quarrying, and ends with extensive sampling of in-process raw-stone and of the finished products. The primary product is a high-purity dolomite grain that has been heated to very high temperatures (this heat treatment yields a product resistant to atmospheric hydration or recombination with CO_2). This "grain" (granular sintered dolomite) is used to manufacture a dolomite brick that is finding increasing use as a refractory product in lining AOD (Argon Oxygen Decarburization) vessels, ladles for the steel making industry, and in lining the burning and transition zones of rotary cement and lime kilns.

Competitive advantages are gained by achieving a sintered dolomite product with only one pass through the kiln. This efficiency is the result of the unique physical and chemical characteristics of the Ledger Formation and Baker Company's pioneering spirit. In fact, these attributes, plus dedication to quality, have made the Baker Company the only manufacturer of a high-purity dolomite grain suitable for the production of a refractory brick in the United States. Besides high-purity refractory products, the company also produces dead-burned dolomite (used to maintain open hearth and electric furnaces used in steel making), pulverized agricultural dolomite, fluxstone, and mineral fillers.

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ADDRESS CORRECTIONS PLEASE!

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NATIONAL HIGH-ALTITUDE PHOTOGRAPHY

High-altitude aerial photographs are a valuable source of information. In 1978, several federal government agencies, with the U.S. Geological Survey leading the effort, decided to coordinate data acquisition programs for aerial photography. Under the National High Altitude Photography (NHAP) Program, the U.S.G.S. is systematically acquiring both black-and-white (scale 1:80,000) and color-infrared (scale 1:58,000) photographic coverage of the 48 conterminous states. By the spring of 1986, the entire U.S. will be covered by the NHAP Program, called NHAP–I. Periodic updates of the data are planned.

Several different types of products are available from the NHAP Program. Both black-and-white and color-infrared photography are produced. The black-and-white photographs are used in map-making, as well as in geologic and land-use analyses. Color infrared photographs are useful in resource inventories, agricultural monitoring, and pollution detection.

The photographs are in a 9-by-9 inch format. The black-and-white print has a scale of 1:80,000 or 1 inch equals 1.25 miles. One black-and-white print covers nearly 130 square miles. Usually 3 exposures are needed to cover the area of a 7½′ quadrangle map. The color-infrared product has a scale of 1:58,000 or 1 inch equals 0.9 mile. Each color-infrared print covers nearly 68 square miles. Four exposures are needed to cover the area of a 7½′ quadrangle map.

Film transparencies or photographic reproductions of black-and-white and color-infrared photographs are available in a 9-by-9 inch contact print size, as well as in standard enlargement sizes of 2X, 3X, and 4X.

As a special feature, all aerial mapping photographs acquired under the NHAP–I Program can also be ordered at a 1:24,000 scale, making them ideal for use with USGS 7½′ topographic maps. Two types of products, black-and-white and color-infrared paper prints, are available. The 1:24,000 black-and-white print is enlarged 3.33X. The 1:24,000 color-infrared enlargement is 2.43X.

Film Size	B & W Scale	B & W Price	CIR Scale	CIR Price
9″ x 9″	1:80,000	$ 5.00	1:58,000	$15.00
18″ x 18″ 2x)	1:40,000	$20.00	1:29,000	$35.00
27″ x 27″ (3x)	1:26,666	$25.00	1:19,333	$50.00
36″ x 36″ (4x)	1:20,000	$35.00	1:14,500	$70.00
22″ x 22″ (2.43x)			1:24,000 appx.	$50.00
30″ x 30″ (3.33x)	1:24,000 appx.	$25.00		

To obtain NHAP photography, determine the geographic coordinates of the specific area and, if possible, delineate it on a map. E-NCIC will select the proper roll and frame numbers to cover your area and advise you of ordering procedures. To obtain further information, or to place an order, please contact the following office.

U.S. Geological Survey
Eastern Mapping Center
536 National Center
Reston, VA 22092
Telephone: (703) 860-6336

NHAP color-infrared products are also available from the Agricultural Stabilization and Conservation Service (ASCS). To obtain ASCS photography determine the geographic area, including county, township, and latitude and longitude. If possible include a map of the area of interest.

Paper Size	Scale Ft/In	Price
10″ x 10″	1:58,000	$ 8.00
12″ x 12″	1:48,000	$25.00
24″ x 24″	1:24,000	$35.00

Address orders for photographs to:

Aerial Photography Field Office
P. O. Box 30010
Salt Lake City, UT 84130

NHAP

mineral collector's open house

faylor
middlecreek
inc

Faylor-Middlecreek, Inc. is holding an "open house" this year on Saturday, September 21st, from 8:00 A.M. to 4:00 P.M. for our rock hound friends.

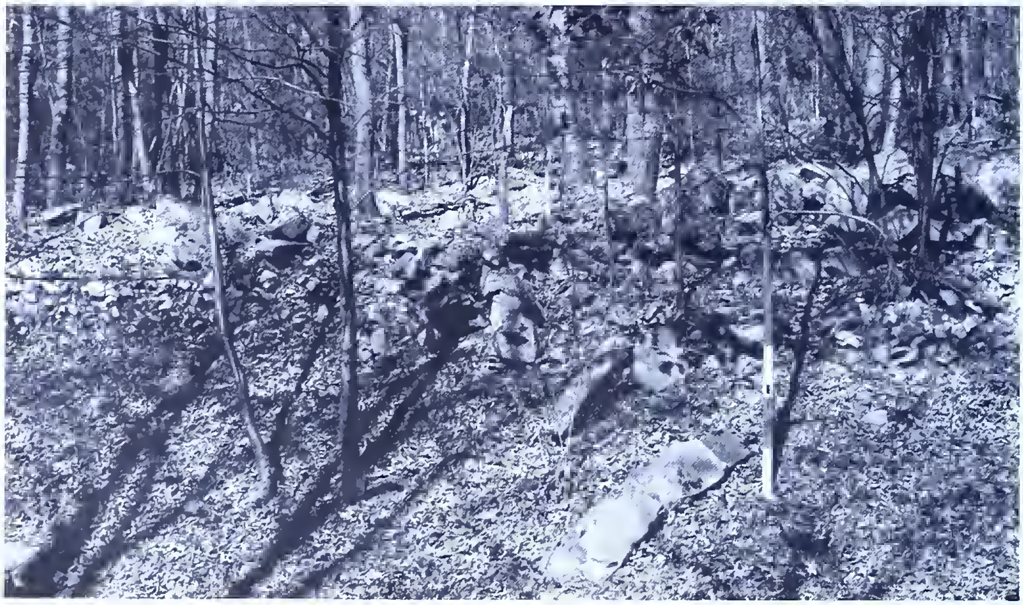
The 1984 operating season was the last year for the old Winfield quarry since the quarry is worked out. The bottom of this quarry is now flooded. A new quarry is being developed to the west and approximately 2500 feet from the old quarry in the same rock. The open house will include this new quarry. Mineral collectors and clubs are invited to explore the unflooded parts of the old quarry as well as the new quarry. There will continue to be $1.00 per adult person charge for registration.

All persons planning to attend should be aware that there is a steep climb into and out of the old quarry and anyone not physically able to climb steep hills coming out of the old quarry on their own should not walk down. Automobiles, trucks, vans, motorcycles, etc., are not allowed at any time in the quarry, but a place to park your vehicle close to the quarry rim is provided. Hard hats, safety shoes, and safety glasses or goggles are required for all collectors.

For more information contact M. Lee Eberhart, Jr., President, Faylor-Middlecreek, Inc., P.O. Box 177, Winfield, Pennsylvania 17889, telephone (717) 524-2251.

HARRISBURG AREA GEOLOGICAL SOCIETY HOLDS 4TH ANNUAL FIELD TRIP

Old and new concepts of Pennsylvania landscape evolution were the focus of the 4th Annual HAGS field trip led by William D. Sevon on April 27, 1985. Thirty four attendees visited 8 localities which illustrated various geomorphological features including: structural control of water gap location, stability and longevity of colluvial deposits, mechanical disintegration of ridge crests, saprolite, and dissected erosion surface (the Harrisburg), old alluvial-fan deposits, and chemical weathering of carbonates. The geomorphic model discussed at length in the guidebook "Pennsylvania's Polygenetic Landscape," proposes that the present landscape of Pennsylvania, and the Appalachians as a whole, is the result of tectonically uninterrupted, climatically controlled weathering and erosion operating continuously since at least the Permian Period. Other concepts held by many, such as peneplains (Davis), a Cretaceous transgression (Johnson), and repeated uplifts of the Appalachians are considered untenable by Sevon.



Two generations of colluvium exposed along the north side of PA Route 74 on the south slope of Blue Mountain, Cumberland County, Pennsylvania. Stop 4 of the 4th Annual Harrisburg Area Geological Society Field Trip.

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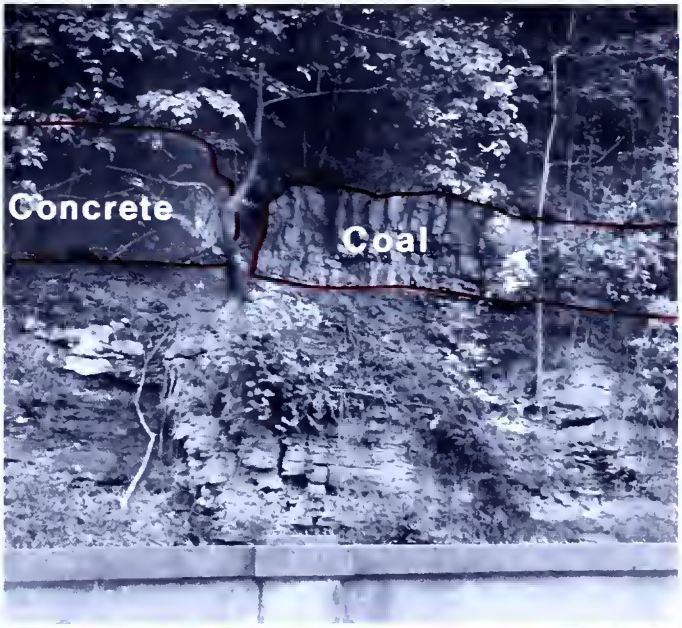
FIRST MINING OF THE PITTSBURGH COAL

"The State's bituminous coal industry was born about 1760 on Coal Hill, now Mt. Washington. Here the Pittsburgh coal bed was mined to supply Fort Pitt. This was eventually to be judged the most valuable individual mineral deposit in the U.S."

A historical marker with this text was dedicated on April 18, 1985. The site is on Grandview Avenue, atop Mount Washington, overlooking downtown Pittsburgh. The exact location of the first mines along the hillside is unknown, so the marker is placed just above the outcrop of the coal along McArdle Roadway.

The following is an excerpt from "History of Allegheny County, Pennsylvania," 1889.

> It was regularly mined as early as 1760, and according to tradition was first tied up in rawhides and tumbled down Coal Hill, now known by the more ambitious title of Mount Washington. The first manufactories started here were supplied from the same source, but the method of transportation was improved. It is said that



Pittsburgh coal seam outcrop along McArdle Roadway, Mt. Washington in Pittsburgh, approximately 50 feet below the marker location. The concrete to the left of the outcrop is probably sealing an old mine opening.

> "coal was hauled down the hill on a sled-car, made of two oak saplings formed as shafts for a horse to work in, and a box fastened onto the outer end of the shafts that would contain fifteen bushels. The road was made with a rut each side about ten inches deep for the ends of the saplings to run in.

Since 1760, more than 1,000,000,000 (one billion) tons of coal have been mined from the Pittsburgh seam in Allegheny County alone. This quantity of coal:

Is equal to the volume of about 3,000 U.S. Steel Buildings (about 550,000 acre-feet);
Would fill 12,000,000 standard rail coal cars, enough to make a train extending about 6 times around the earth;
Has enough heating value to bring Lake Michigan to a boil (about 1,100 cubic miles of water).

Placement of the marker was through the joint efforts of the Pennsylvania Historical and Museum Commission and the Pittsburgh Geological Society. The dedication occurred on the date of the 40th anniversary of the founding of the Pittsburgh Geological Society.

Helen L. Delano

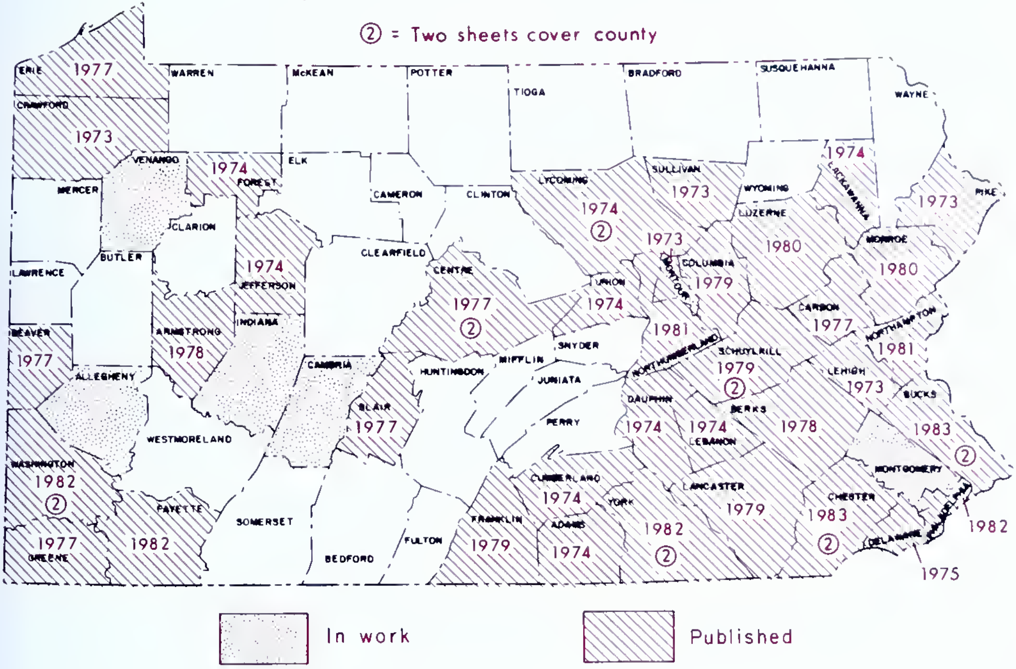
USGS ISSUES ADDITIONAL SMALLER SCALE MAPS FOR PENNSYLVANIA

In an effort to meet the continuing need for smaller scale maps, the USGS has published six new maps in the 1:100,000 scale quadrangle series and eight in the 1:50,000 scale county topographic series since our last report.

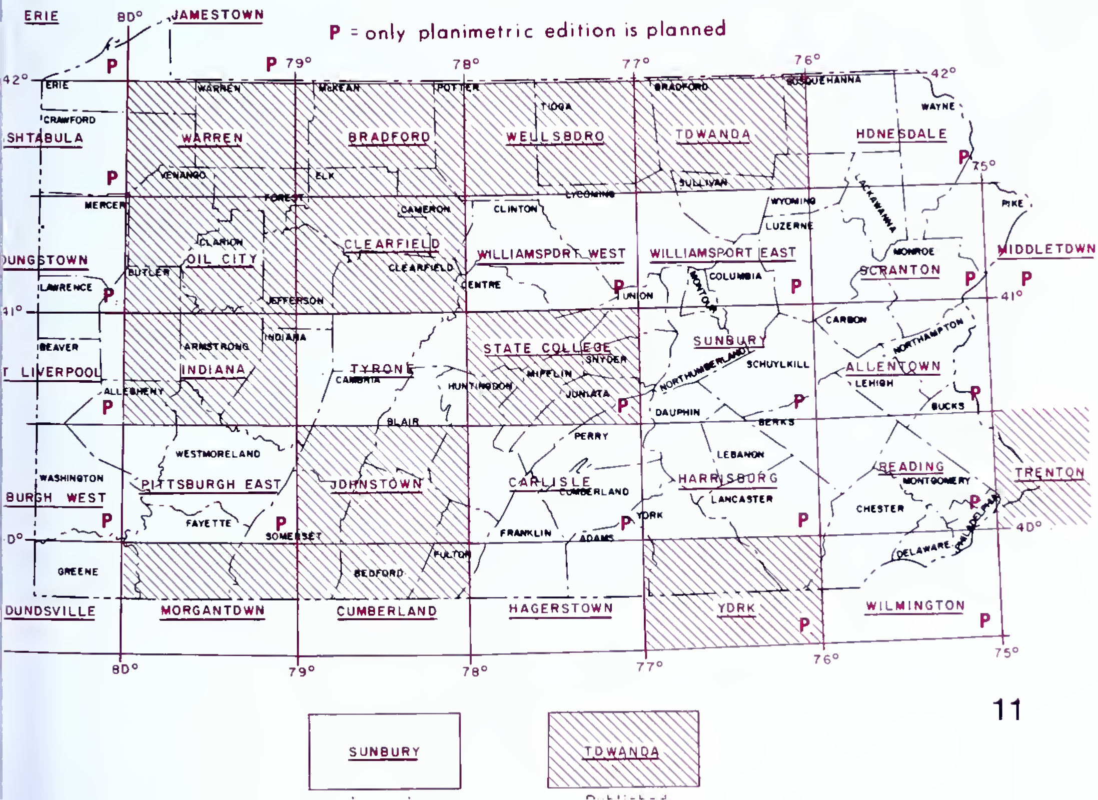
Chester County is the most recent addition to the list of completed maps in the 1:50,000 county topographic map series. Because of size, the county is divided into two sheets, north and south. Since our last notice in April 1983, additional counties released by the USGS are: Bucks (2 sheets), Fayette, Monroe, Northampton, Northumberland, Philadelphia, Washington (2 sheets), and York (2 sheets). Maps for 36 Pennsylvania counties are now available from the USGS.

Five maps newly completed in the 1:100,000 scale topographic series include: Clearfield, Indiana, Oil City, Trenton, and Warren. Eleven maps at this scale are now available for Pennsylvania. In addition, York and State College have been recently issued in the planimetric edition (planimetric maps are those which lack contours).

1:50,000-SCALE COUNTY TOPOGRAPHIC MAPS



1:100,000-SCALE QUADRANGLE MAPS



Published maps in both series are available at $4.00 each sheet from Eastern Distribution Branch, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202.

The Lehigh County 1:50,000 map (Map #39) costs $1.65 and is available by writing to the State Book Store, P.O. Box 1365, Harrisburg, Pennsylvania 17105 (prepayment is required, Pennsylvania residents should add 6% sales tax, and make check payable to the "Commonwealth of Pennsylvania").

STATE BOOK STORE MOVES

The State Book Store has moved to 20 South Third Street, Harrisburg. The mailing address (P.O. Box 1365, Harrisburg, PA 17105) and telephone number (717-787-5109) remain the same.

NEW RELEASES FROM THE U.S.G.S.

White Clays of Pennsylvania, USGS Bulletin 1558-D, by John W. Hosterman. Price $2.00 (includes postage).

Storm Induced Slope Movements at East Brady, Northwestern Pennsylvania, USGS Bulletin 1618, by John S. Pomeroy. Price $1.50 (includes postage).

The Richmond and Greenwich Slices of the Hamburg Klippe in Eastern Pennsylvania—Stratigraphy, Sedimentology, Structure, and Plate Tectonic Implications, USGS Professional Paper 1312, by Gary G. Lash and Avery A. Drake, Jr. Price $2.25 (includes postage).

These publications may be ordered from Eastern Distribution Branch, Text Products Section, U.S. Geological Survey, 604 S. Pickett Street, Alexandria, VA 22304.

Geologic map of the Kutztown quadrangle, Berks and Lehigh Counties, Pennsylvania, USGS Geologic Quadrangle Map GQ-1577, by Gary G. Lash. Price $3.60 (includes postage). This publication may be ordered from Eastern Distribution Branch, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202.

Make checks payable to *U.S. Geological Survey.*

OIL AND GAS RESERVOIR ROCKS OF PENNSYLVANIA

Work is in progress in the Pittsburgh office of the Pennsylvania Geological Survey to compile a handbook of the petrologic and petrophysical data of the various hydrocarbon reservoir rocks of the Commonwealth. The report, being compiled by Christopher D. Laughrey and Robert M. Harper of the Oil and Gas Geology Division, is intended to be used in context with the recently issued Oil and Gas Fields Map of Pennsylvania (Pennsylvania Geological Survey Map #3). Every effort is being made to obtain and organize sample information from the oil and gas fields of the state into a format compatible with the objectives of the compilation. These objectives are:

1) To outline the chemical and physical properties (mineralogy, texture, diagenesis, porosity, and permeability) of the principal reservoir rocks in each of five general productive areas of western Pennsylvania (northwest, north-central, southwest, central-west, and south-central).

2) To explain the variations from low-permeability ("tight") to high-permeability ("sweet") zones in seemingly similar reservoir situations.

3) To relate the chemical and physical properties to depositional environments and reservoir configurations of the gas and oil pools in Pennsylvania.

4) To discuss the potential reservoir and completion problems operators may expect due to variations in chemical and physical properties.

The study entails the compilation of thin-section and scanning electron microscope (SEM) data, core analyses, X-ray diffraction data, and geophysical (wire-line log) information. The report will be in the form of a book of summarized data, photographs, and line drawings similar to the Survey's previously published Engineering Characteristics of the Rocks of Pennsylvania (Environmental Geology Report #1). Laughrey and Harper are tentatively calling their study *Oil and Gas Reservoir Rocks of Pennsylvania*. It is scheduled to be completed by December, 1986, with probable publication in 1987. The book should provide operators with a comprehensive guide to geological appraisal of Pennsylvania's reservoir rocks and make available fundamental data for planning profitable exploration and expoitation programs.

Mahantango Conulariid Considered a Hyolithid

by Loren E. Babcock
Department of Geology
Kent State University

An unusual fossil shell from the ancient seas that once covered central Pennsylvania is now believed to have been misidentified. Proper identification will provide a more accurate interpretation of the oceanic and geologic conditions which existed at the time that the particular life form roamed the sea bottom.

Conulariids, which are invertebrates of uncertain affinities, are among the most unusual of Paleozoic fossils found in Pennsylvania. Although they are known from nearly all marine facies types, their remains are generally scarce. Moreover, because of morphological similarities to other organisms, they are easily confused with other fossils, giving us a false impression of their stratigraphic and geographic distributions.

Ellison (1965, p. 48, pl. 4, fig. 1) figured and described a small conoidal fossil from the Frame Shale Member of the Mahantango Formation (Middle Devonian: Givetian) at Huntingdon, Pennsylvania. The specimen was described as "*Conularia* sp." As far as I can determine, it is the only published record of a conulariid from the Mahantango Formation. The specimen (Figure 1) is in the United States National Museum of Natural History (USNM 173928). Reexamination of this specimen shows that it is a hyolith rather than a conulariid. Hyoliths are conical-shaped Paleozoic mollusks.

The fossil has a compressed conical shape, 14 mm in length, and is preserved in dark gray shale. The apex is slightly rounded, and the edges diverge at 26 degrees. Marginal areas are flattened and separated from the more convex central region by narrow grooves. An irregular line is prominent along most of the specimen near the line of bilateral symmetry. This feature seems to be a crack resulting from compression, not a median groove as interpreted by Ellison. Ornamentation consists of fine smooth lines that are closely spaced and uniformly curved, concentric about the apex.

I interpret the specimen as a hyolith having the dorsal side exposed. Compaction of the sharp carina has cracked the specimen, but because the specimen expands aperturally, the apical region

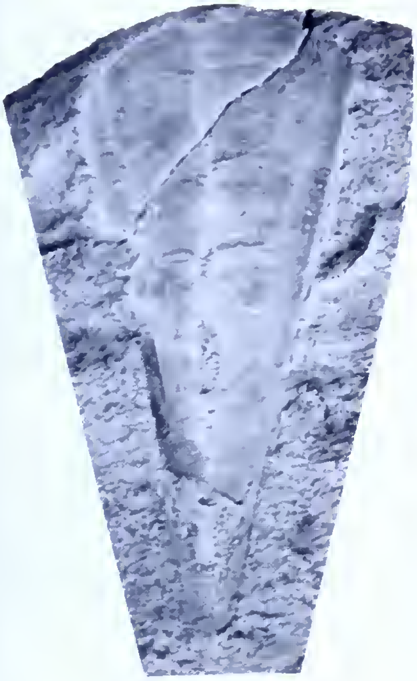
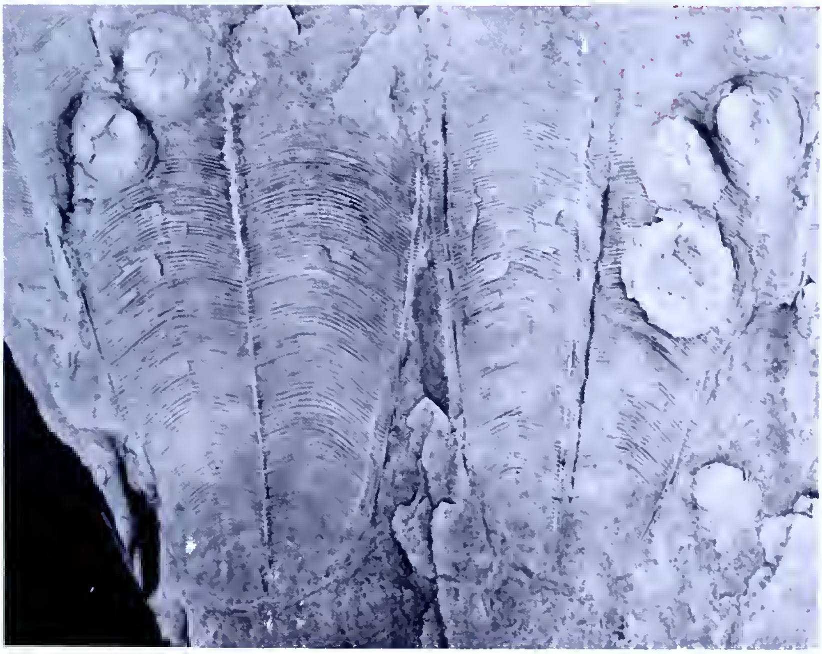


Figure 1. *Hyolithes* sp. from the Frame Shale Member, Mahantango Formation (Middle Devonian) at Huntingdon, Huntingdon Co., Pennsysylvania. View of dorsal side, x5. USNM no. 173928.

Figure 2. Hypotypes of *Conularia congregata* Hall from the "Ithaca Beds"(Upper Devonian) near Ithaca, New York, x1. New York State Museum no. 3483. Inarticulate brachiopods are attached to the integuments of the conulariids.



does not show as much crushing. There is no evidence of a "corrugated" pattern of transverse lines, an important characteristic of conulariids (Figure 2). Interspaces are not crossed by bars or striae. The aperture is intact, and forms a broad arcuate ligula; conulariids typically show bluntly subtriangular terminations on each face.

On the basis of general size and shape, it is easy to imagine how this particular fossil might be identified as a conulariid. Because the specimen has been broken by compaction, this individual even appears to have a median line, a feature which would have suggested that the animal was four-sided. Moreover, the ligula, which is the curved apertural extension of the dorsal side of a hyolith, mimics the so-called "apertural lappets" of a conulariid.

Although this reported occurrence of a conulariid has turned out to be spurious, conulariids may be present in the Mahantango Formation, as they are in other Paleozoic strata of Pennsylvania. Much remains to be learned about the nature of the conulariids of Pennsylvania and elsewhere; little is known with certainty about the biology and stratigraphic distribution of this group of animals.

Reference

Ellison, R. L. (1965), *Stratigraphy and paleontology of the Mahantango Formation in south-central Pennsylvania,* Pennsylvania Geological Survey, 4th ser., General Geology Report 48, 298 p.

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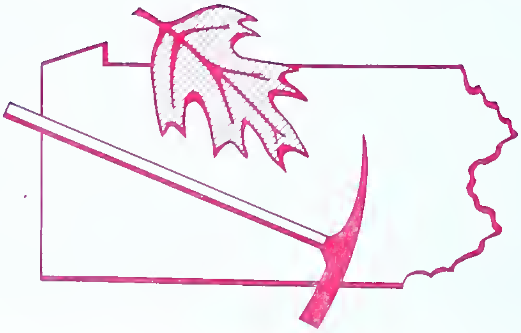

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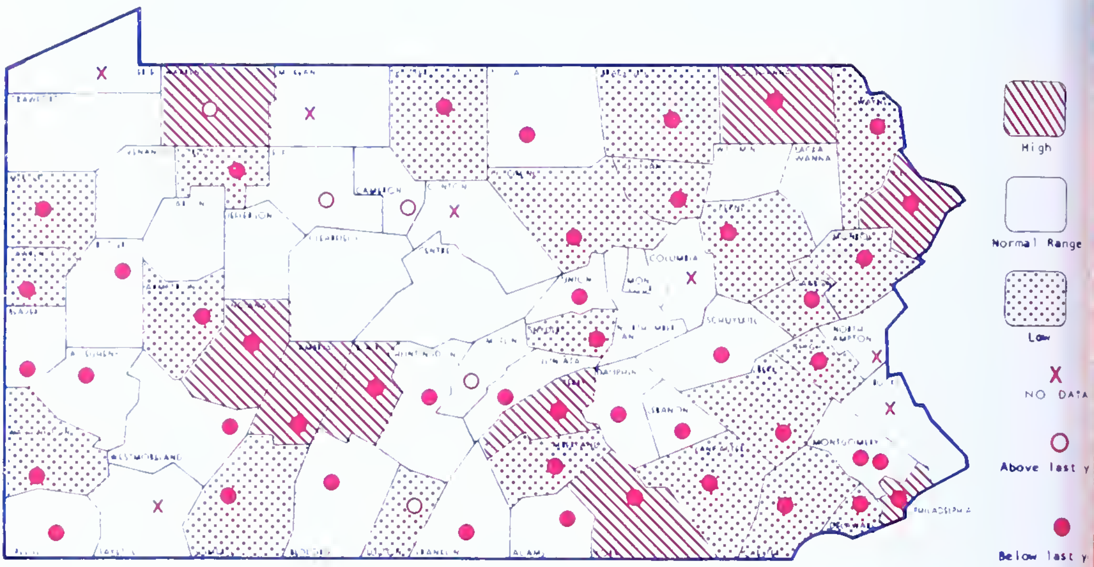

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ON THE COVER: Oil well pump "graveyard," south of Grand Valley (1/4 mile west of Pa. Route 27) in Warren County, Pennsylvania. The equipment is testimony of the intensive drilling and production activity in this area for over a century. Photo courtesy of Tom and Michael Berg.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

VOL. 16, NO. 4 **AUGUST, 1985**

FROM THE DESK OF THE STATE GEOLOGIST

DATA DATA EVERYWHERE

With the exception of the achievements of a few rare geniuses (a la Einstein), advances in science are made on the basis of accumulation, interpretation, and analysis of data. This is the time-consuming, non-glamorous aspect of science, the phase for which it is commonly difficult to gain adequate support, since positive results can never be assured, and at best, are likely to be years in coming.

Geology too requires data collection and evaluation, both for the advancement of basic scientific principles, as well as for direct applications, such as the management of geologic resources. At the Pennsylvania Geological Survey we have been accumulating such data since the inception of the Survey in 1836. In the last 30 years the volume of our accumulated geologic data has greatly escalated, in part due to expanded geologic field investigations and in part due to legislation resulting in voluminous input of water well data and of data from new oil and gas wells.

The advent of the computer offers scientists a tremendous "tool" for handling of massive quantities of data, both for storage and rapid retrieval and particularly for data analysis and evaluation. At the Pennsylvania Survey we are trying to utilize this "tool" and have been working at develping operational computer data programs for our accumulated water well records (over 60,000 on hand and some 15,000 new well records arriving yearly), our oil and gas well data (over 70,000 well records on hand), a comprehensive directory of Pennsylvania mineral producers, and a detailed data file of the physical and chemical properties of Pennsylvania's coal resources (including coal reserves and structures). The coal resources data bank is being developed with the cooperation and support of the U.S. Geological Survey's National Coal Resources Data System.

(Continued on page 31)

Pennsylvania's Valuable Nonfuel-Mineral Production

While Pennsylvania is reknowned for its outstanding coal, oil, and gas production, the Commonwealth also has traditionally had a high national ranking with respect to nonfuel-mineral production. In fact, Pennsylvania's mineral production and the people who produced it helped win the Revolutionary, Civil, and World Wars. It has also provided construction materials for homes and industry as well as improving the state's agricultural production. There is an old adage in the mining fraternity that states "if it doesn't grow, it's mined." Pennsylvania is unique in that early development and industrialization was promoted in this state by the rich abundance of naturally occurring mineral resources. This, combined with developing transportation networks and harbors, provided a sound foundation for our country's world status.

Preliminary data for 1984 have recently been published by the United States Bureau of Mines which estimated the Commonwealth's nonfuel-mineral production to exceed $600 million for the year (Prosser, 1985). Table 1 is a modified listing of this data which shows production, value, average price per ton, and approximate percen-

Table 1. ***Nonfuel-Mineral Production in Pennsylvania for 1984***
(Modified from Prosser, 1985)

MINERAL	QUANTITY *(thousands of short tons)*	VALUE *(thousands of dollars)*	VALUE *(dollars per ton)*	PERCENTAGE OF TOTAL VALUE
CEMENT				
Masonry	295 tons	$ 19,480	$66	3%
Portland	5,600	240,000	43	37
CLAYS (mostly shale for brick manufacture but includes refractory, excludes kaolin)	934	4,689	5	<1
LIME (used for steel making, acid neutralization-environmental, and agriculture)	1,620	85,595	53	13
PEAT (used for agriculture and horticulture)	24	707	29	<1
SAND AND GRAVEL				
Construction (used for aggregate, concrete, and road base)	13,200	57,000	4	9
Industrial (used for glass, foundry, chemical, and metallurgical processes)	860*	12,000*	14*	2*
STONE				
Crushed (used for construction aggregate, road stone road base, and cement manufacture)	56,200	232,000	4	35
Dimension (sandstone, diabase, and slate, both as dressed and rough products)	44	6,001	136	<1
TOTALS	78,777	$657,472		

*USBM 1983 data.

tage of total value for major commodity groupings. Portland cement, crushed stone, and lime account for more than 80% of the total value of nonfuel minerals produced in 1984. The order, based on dollar value per ton, shows dimension stone as the leader followed by masonry cement, lime, and portland cement, respectively. In recent years Pennsylvania nationally ranked first in the production of masonry cement, and third in the production of portland cement, lime, and stone.

For every man, woman, and child living in the Commonwealth, about $55 worth, or about 7 tons, of nonfuel minerals was produced. Put another way, about $14,600 of production per square mile was achieved in 1984, not including coal, oil, and gas!

Pennsylvanians should be proud of their mineral heritage and the people engaged in extracting its resources. Production of crushed stone provides economical and safe material to build and repair the Commonwealth's highway system. Portland cement is a basic construction material needed for continued growth. Lime produced in Pennsylvania is used mostly in the production of steel, a major heavy industry of the area. These mineral industries provide both skilled and nonskilled jobs for our labor force.

In accordance with its legislative mandate, the Pennsylvania Geological Survey, through its Mineral Resources Division, seeks to provide clear insight into the character of the Commonwealth's mineral resources and insure that this information is available in a readily usable form. Our newly revised *Directory of the Nonfuel-Mineral Producers in Pennsylvania* is soon to be released and is an example of this effort.

REFERENCES

Prosser, L. J. (1985), *The mineral industry of Pennsylvania in 1984,* Mineral Industry Surveys, U.S. Dept. of the Interior, Bureau of Mines, 2 p.

United States Bureau of Mines (1982), *Minerals Yearbook, 1980, Volume II, Area reports: domestic,* U.S. Dept. of the Interior, 603 p.

GEM AND MINERAL SHOW

The Central Pennsylvania Rock and Mineral Club will hold its 20th Annual Gem and Mineral Show on September 21 and 22 at the Zembo Temple, 2801 N. Third Street, Harrisburg. The hours are 10 a.m.–7 p.m. on the 21st, and 10 a.m.–5 p.m. on the 22nd. Admission is $1.50 for adults; parking is free.

GEOLOGICAL RESEARCH IN PENNSYLVANIA

1985

INTRODUCTION

This publication is the twenty-eighth annual report on Geological Research and Publications in Pennsylvania. It is an attempt to list all current geologic research in Pennsylvania and includes persons and projects other than those of the Pennsylvania Geological Survey. Because of the large number of projects reported to us, we exercise editorial license to reduce the description of the research projects to fit our available space.

We have also attempted to determine an anticipated completion date (ACD) for each project. The anticipated completion date is the estimate of the date when the author will complete his report; additional time should be anticipated until the report is published. *If you wish more information on a project described herein, please write directly to the author; most of these projects will not be published by the Pennsylvania Geological Survey inasmuch as most are not Survey sponsored projects.*

The listings are grouped into major categories of research to facilitate your search for information on a particular subject. Reports published are listed alphabetically by author.

As with all compilations, there may be omissions; this is unintentional. Additional copies of this report may be obtained by writing to the Bureau of Topographic and Geologic Survey, Department of Environmental Resources, P.O. Box 2357, Harrisburg, Pennsylvania 17120.

T. M. BERG, Pa. Geol. Survey, **MICHAEL O'NEILL,** Shippensburg Univ., and **JACKIE LUNDY,** Bloomsburg Univ. Geologic Base Map of Warren Co., Pa. The map will be used as a base for a groundwater report on Warren County being done in cooperation with the Water Resources Division of the U.S. Geological Survey. The preliminary compilations are completed. Brief field checking will be done, and the final map will be transferred to a 1:50,000 base. ACD: Summer 1985.

W. E. DAVIES, Retired, U.S. Geol. Survey, and **G. C. OHLMACHER,** Purdue Univ. Geology of the Cumberland 1:100,000 Map Sheet. Geologic mapping in Bedford and Fulton Counties completed; preparation of maps for 1:100,000 sheet underway. Subjects in atlas form cover areal geology, engineering geology, structural geology, and cultural features related to geology. ACD: Early 1986.

J. B. EPSTEIN and **P. T. LYTTLE,** U.S. Geol. Survey, and **G. G. LASH,** SUNY, Coll. at Fredonia. New Tripoli 7½′ Quad. Completed mapping New Tripoli 7½-minute quadrangle. Final compilation underway. Completed compilation of Newark 2-degree quadrangle. ACD: 1986.

A. J. FROELICH, Project Chief, U.S. Geol. Survey. Early Mesozoic Evolution of the Eastern U.S. Mapping of the distribution of lithology and age determinations of sedimentary rocks (Triassic-Jurassic), including fossil localities and Mesozoic faults (outside as well as within basins), will continue during FY 1985. ACD: FY 1987.

J. D. INNERS, Pa. Geol. Survey. Geology and Mineral Resources of the Hazleton Quad., Luzerne, Carbon, and Schuylkill Cos., Pa. ACD: None set.

E. F. KOPPE, Consultant. Coal Geology and Structure of the Blossburg Coal Basin, Tioga Co., Pa. Detailed mapping of coals and status of mining throughout the Blossburg basin reveals loss of significant coal reserves by glacial cutouts. ACD: 1986–87.

T. J. KUNTZ and **N. K. FLINT,** Univ. of Pittsburgh. Regional Study of Vanport Limestone in Elk Co. ACD: Dec. 1985.

H. W. SCHASSE, Washington Geol. Survey, and **D. B. MacLACHLAN** and **J. D. INNERS,** Pa. Geol. Survey. Geology and Mineral Resources of the Conyngham Quad., Luzerne and Schuylkill Cos., Pa. Study emphasizes anthracite resources and includes preparation of a detailed coal map at scale 1:12,000. Reserve calculations are completed. ACD: July 1986.

ECONOMIC GEOLOGY

S. W. BERKHEISER, JR., Pa. Geol. Survey. High-Purity Silica Deposits in Pa. Potential high-purity silica sources from nine Paleozoic formations and six quartz veins were sampled, chemically analyzed, and described from 30 locations representing 14 counties in central and eastern Pa. Percent Al_2O_3 and Fe_2O_3 are reported for as-collected and beneficiated splits. Beneficiation consisted of hot acid baths and magnetic separation. Potential resources for various manufactured silica products have been identified. ACD: In press.

S. W. BERKHEISER, JR., Pa. Geol. Survey. Pa.'s Slate Industry: Alive and Well [Lehigh, Northampton, and York Cos.]. The Lehigh-Northampton slate district is unique in that in addition to producing flagging, flooring tiles, blackboards, roofing, and structural slates, it is the only U.S. producer of electrical and billiard slates. This district produces over $4 million worth of slate products annually. The geology, mineralogy, mining, milling, and marketing of Pa.'s slate industry is summarized. ACD: In press.

S. W. BERKHEISER, JR., Pa. Geol. Survey, and **J. A. AMES,** Consultant. Limestone-Dolostone: Specialty Uses, Chapter 42D *in* The Geology of Pennsylvania. The carbonate rocks of Pennsylvania have played a long and historic role in the industrial and agricultural development of the state and nation. Limestones and dolostones represent about 80 percent of all rocks currently mined in the Commonwealth. The distribution and uses of the carbonate rocks will be summarized by physiographic province, and a brief historical perspective of carbonate mining in Pennsylvania will be presented. High-purity carbonates will be emphasized. ACD: In preparation.

S. W. BERKHEISER, JR., and **J. H. BARNES,** Pa. Geol. Survey. Clay and Shale, Chapter 42B *in* The Geology of Pennsylvania. The geology, mineralogy, and distribution of Pennsylvania's clay and shale mining industry will be summarized. Construction markets for this resource include impermeable barriers, pottery, bricks and tile, lightweight agggregate, borrow and fill material, and sources of Al_2O_3 for cement manufacture. Pa's high-alumina clay is noted for its refractory qualities. A compilation of white-clay sources is anticipated. ACD: In preparation.

S. W. BERKHEISER, JR., J. H. BARNES, and **R. C. SMITH, II,** Pa. Geol. Survey. Directory of the Nonfuel Mineral Producers in Pa. This compilation will provide a directory of the approximately one-half billion dollar nonfuel mineral industry in Pennsylvania. Mineral commodity, county, and producer listings include addresses, telephone numbers, list of products, producing formations, and lithologies. A location map at a scale of 1:500,000 will be included. ACD: In press.

G. M. FLEEGER. Possible Effects of Basement Tectonics on the Geometry of the Tuscarora Fm.-Medina Group of Northwestern Pa. Tuscarora-Medina geometry, previously interpreted to be the result of a deltaic depositional environment, is similar to that of other sedimentary units, thought possibly to be affected by basement tectonics. ACD: Sept 1985.

A. D. GLOVER, C. H. DODGE, J. G. PHILLIPS, J. R. SHAULIS, and **V. W. SKEMA,** Pa. Geol. Survey. Coal Resource Maps for All Bituminous-Coal-Bearing Counties, Main Bituminous Field, Western Pa. This study is an updated coal resource evaluation for this field. Part 1 will include crop lines for each of the principal coal seams, areas of deep and strip mining, and structure contours on a particular coal. Maps for Greene County have been published. Maps for Allegheny, Butler, Fayette, Washington, and Clarion Counties have been submitted for drafting. Cambria and Westmoreland County maps will be completed in 1985. ACD: 1990.

R. M. HARPER and **C. D. LAUGHREY,** Pa. Geol. Survey. Oil and Gas Reservoir Rocks of Pa. This report will use the integration of rock-pore data with laboratory petrophysical data, log-derived data, and geology for Pennsylvania's hydrocarbon reservoirs. These data will be used for classification of reservoir lithologies into pore types for the purpose of establishing reservoir-rock potentials. ACD: 1986.

J. D. INNERS, Pa. Geol. Survey. Sedimentary and Metasedimentary Iron Deposits in Pa., Chapter 41A *in* The Geology of Pennsylvania. ACD: 1986.

G. R. ROBINSON, Project Chief, U.S. Geol. Survey. Metallogeny of the Early Mesozoic Basins of the Eastern U.S. Studies of the geochemical and mineralogical character of the eastern U.S. Mesozoic basalt and diabase will continue in FY 1985. Emphasis will be on understanding platinum-group-element systematics in tholeiitic systems and their use as a sensitive indicator of sulfide fractionation. Compilation of data on ore deposits, prospects, and occurrences associated with the eastern U.S. early Mesozoic basins will continue also. A geochemical study of base metal-barite vein occurrences associated with the eastern U.S. Mesozoic basins will be initiated. ACD: FY 1988.

J. B. ROEN, Project Chief, U.S. Geol. Survey. Paleozoic Black Shales, Appalachian Basin. Funding has been provided by the Department of Energy for the collection of Paleozoic black shales for geochemical analysis for source-bed potential. Devonian shales and oil samples will also be collected for geochemical fingerprinting to determine oil source and migration paths. Subsurface data will be used to determine the stratigraphy and distribution of Ordovician shales. Open-file reports for the Department of Energy on the progress of this research will be prepared on a regular basis. ACD: FY 1986.

R. C. SMITH, II, and **J. H. BARNES,** Pa. Geol. Survey. U-Th in the Reading Prong, Eastern Pa. A 1:50,000-scale map of carborne gamma-ray anomalies is being released as a possible guide to indoor radon.

Petrographic study indicates several different types of occurrences in this uraniferous province. ACD: Aug. 1985.

R. W. STANTON, Project Chief, U.S. Geol. Survey. Coal Petrology. Additional samples from the Upper Freeport limestone outcrops in Ohio and Pennsylvania were collected for analysis in FY 1984. Sets of roof-rock and coal have been submitted for chemical analyses to evaluate the effect of roof-rock lithology on the sulfur content of coal. Reports describing nondestructive methods to predict variability in coal washability and interpreting petrographic data from five different physical depositional environments are being reviewed. ACD: FY 1989.

ENGINEERING GEOLOGY

W. E. DAVIES, Retired, U.S. Geol. Survey, and **G. C. OHLMACHER, J. S. POMEROY, WILLIAM OUTERBRIDGE, ROGER THOMAS,** and **STEPHEN OBERMIER,** U.S. Geol. Survey. Appalachian Slope Stability [Appalachian Plateau in Pa.]. Preparation of final report on distribution, physical characteristics, and causes of slope failures in the Appalachian Plateaus. Completion of 7½-minute quadrangles of the Pennsylvania portion of the Cumberland 2-degree sheet showing distribution and classification of landslides. ACD: Early 1986.

J. P. WILSHUSEN, Pa. Geol. Survey. Land Subsidence in Carbonate Terrain, chapter *in* The Geology of Pennsylvania. A chapter, outlined in eight sections, that discusses the location, topography, geologic framework, weathering, and subsidence problems and their prevention and correction in limestone and dolomite bedrock. ACD: Oct. 31, 1985.

ENVIRONMENTAL GEOLOGY

W. R. ADAMS, JR., Adams Geotechnical Consultants/Univ. of Pittsburgh, and **N. K. FLINT,** Univ. of Pittsburgh. Landsliding in Allegheny Co., Pa.—Characteristics, Causes, and Cures. Approximately 175 slope movements have been investigated for this Ph.D. research project. The intent is to use data from the field reconnaissances and published materials to develop a model to describe the stability of slopes in Allegheny County. ACD: Aug. 1986.

H. L. DELANO and **J. P. WILSHUSEN,** Pa. Geol. Survey. Landslide Susceptibility in the Williamsport 1° x 2° Map Area, Pa. A map and text outlining general landslide susceptibility based on analysis of geological and other factors for known occurrences in the study area. ACD: 1985.

T. W. GARDNER, Pa. State Univ. Watershed Dynamics of Surface Mined Basins. This ongoing research involves analysis of the controls on and evolution of infiltration rates on reclaimed surface mines with the ultimate goal of hydrologic modeling and understanding of the geomorphic evolution of reclaimed mines. ACD: Ongoing.

ALAN GEYER, Geologic Consultant, and **W. H. BOLLES,** Pa. Dept. of Education. Outstanding Scenic Geological Features of Pa., Vol. 2. One hundred thirty-nine outstanding geologic features, not previously described in Volume 1, will be included in this volume. Lists of named springs and waterfalls will also be included. ACD: 1986.

S. T. PEES, Samuel T. Pees & Associates. The Early Days Along Oil Creek Pa. (1859–1865) [Venango Co.]. This study traces the major early oil strikes down Oil Creek and describes the geology of the shallow sands which they tapped. Period photographs and engravings are compared to the Creek as it is today. ACD: Nov. 1985.

A. W. ROSE and **ADAM HUTTER,** Pa. State Univ. Geologic Controls on Radon in Buildings in Pa. Available data suggesting a significant proportion of high radon values in limestone areas will be verified, and the regional and local causes studied in order to help predict risk levels. ACD: Sept. 1986.

JOHN WASHINGTON, A. W. ROSE, and **D. E. BAKER,** Pa. State Univ. Zn, Cd, Pb Contamination in Soils and Waters Around the Palmerton Zinc Smelter. Cd in soil exceeds 1.5 ppm for an average of 7.5 miles from the smelter and Zn exceeds 300 ppm for about 10 miles from the smelter, but well waters are little affected. ACD: June 1985.

ROBERT WEISS and **N. K. FLINT,** Univ. of Pittsburgh. Landslide Hazards in Penn Hills Twp., Allegheny Co. ACD: Dec. 1985.

W. B. WHITE and **JOHN KASTRINOS,** Pa. State Univ. Nitrate Transport in Carbonate Aquifers of Central Pa. [Centre Co.]. Nitrate, sulfate, and chloride levels are being monitored in a dozen springs and surface streams linked to the Ordovician carbonate aquifer. Nitrate levels are being correlated with source areas and with seasonal effects. ACD: Fall 1985.

GENERAL GEOLOGY

J. A. CICIARELLI, Pa. State Univ. Structural Controls on Breaching of An Appalachian Anticline [Tuscarora Mountain anticline].

JANE EGGLESTON, U.S. Geol. Survey. Basin Analysis of the Pa. Anthracite Region. Project efforts are concentrated on the Northern Anthracite field, where stratigraphy and structure are being developed. The project also includes paleobotanical studies, characterization of the Mill Creek limestone, and depositional interpretations. ACD: Fall 1989.

J. L. JONES, York County Parks. Geology of the York County Parks, York Co., Pa. Detailed geologic mapping of the six county parks is currently underway. Each park is located in a different stage of the regional geology. Points of interest, rock and structural descriptions, and geologic maps of each park will be included. ACD: Sept. 1985.

C. H. SHULTZ, Slippery Rock Univ./Pittsburgh Geol. Soc. "The Geology of Pennsylvania" is a writing project initiated and developed by the Pittsburgh Geological Society. C. H. Shultz is serving as editor. All aspects of the State's geology will be summarized. More than 70 authors from industry, government, and academia are participating. Most manuscripts are now undergoing technical review and editing, or are being revised. The Pennsylvania Geological Survey will be the publisher. ACD: Spring 1986.

GEOCHEMISTRY

J. M. McNEAL, Project Chief, U.S. Geol. Survey. Sulfur Isotopes in Triassic Basins. Over 150 ground-water samples were collected in FY 1984 and S-isotopes and chemical analyses are nearly complete. Follow-up water sampling for areas of interest identified by these analyses will be underway in FY 1985. Chilled diabase samples will be collected from the Zora Ring Complex in Pennsylvania and the Culpeper basin in Virginia. If time permits, NURE data in Pennsylvania and Virginia Mesozoic basins will be examined and compiled. ACD: FY 1988.

A. A. ROBERTS, Project Chief, U.S. Geol. Survey. Geochemical Prospecting Utilizing Gaseous Emanation. Helium surveys were completed in FY 1984 over a known fault in Pennsylvania that is intruded by a peridotite dike; higher helium in near-surface soil gases was present in areas very close to the fault (within a couple of hundred feet). Surveys were also conducted in an area in northern Pennsylvania containing the Tyrone-Mount Union lineament. Possible correlation with the lineament and determination of whether or not helium surveys are useful in mapping extensions of the zone of increased fracture permeability will have to await more detailed analysis of the survey results. ACD: FY 1987.

GEOMORPHOLOGY

K. F. CONNORS and **T. W. GARDNER,** Pa. State Univ. Simulated SPOT Imagery for the Investigation of Geomorphic Features and

Hydrologic Processes [Snow Shoe and Pine Glen, Pa.]. Simulated SPOT imagery has been used to identify mine spoil types of different lithologies and vegetative covers. Surfaces with high and low runoff rates can be discriminated. Groundwater recharge and discharge sites can be identified.

ULDIS KAKTINS, Univ. of Pittsburgh, Johnstown, and **H. L. DELANO,** Pa. Geol. Survey. Drainage Basins of Pa., chapter *in* The Geology of Pennsylvania. ACD: Summer 1985.

W. B. WHITE, Pa. State Univ. Caves of Pa. Data, including locations, physical description, and maps are being collected for the caves in the Valley and Ridge and Great Valley provinces. The object is to produce a complete catalog of Pennsylvania caves. ACD: 1988.

W. B. WHITE and **E. L. WHITE,** Pa. State Univ. Karst Landforms in the Appalachian Highlands [carbonate areas of Pa.]. The study is concerned with quantitative landform morphology, drainage basin evolution, and mechanisms of landform sculpture in the Appalachian karst.

GEOPHYSICS

J. D. PHILLIPS, Project Chief, U.S. Geol. Survey. Geophysical Mapping of Early Mesozoic Basins. Compilation activities in FY 1985 include digital aeromagnetic data sets and maps for the northern Hartford, Newark, Gettysburg, Culpeper, Davie County, Durham, and Wadesboro basins; and digital gravity data sets and maps for the Gettysburg, Culpeper, Farmville, Scottsville, and Richmond basins. Field work to acquire gravity data will continue in the Gettysburg and Newark basins. Aeromagnetic data for the Hartford, Newark, Gettysburg, and Culpeper basins will be digitized, and truck magnetometer surveys of the Gettysburg, Newark, Richmond, Durham, and Wadesboro basins will be conducted. ACD: FY 1987.

GLACIAL GEOLOGY

D. D. BRAUN, Bloomsburg Univ., and **WILLIAM BRENNAN,** SUNY, Coll. at Geneseo. Development of a Secular Geomagnetic Declination Record for Use in Correlating Ice Margin Positions Across the Allegheny Plateau in North Central Pa. Proglacial lake rhythmites will be sampled in conjunction with mapping of glacial deposits in selected valleys. Geomagnetic declination values will be examined to see if groupings of similar values can be traced across the Plateau. ACD: 1988.

D. D. BRAUN, Bloomsburg Univ., and **J. D. INNERS,** Pa. Geol. Survey. Extent of Pre-Wisconsinan Glaciation in the Anthracite Region of Pa. Mapping of glacial deposits and buried valley segments is being undertaken to the southwest of the Wisconsinan glacial limit between the North Branch Susquehanna and Lehigh Rivers. ACD: 1987.

W. D. SEVON, Pa. Geol. Survey. Glacial Deposits Mapping in Northeastern Pa. [all of glaciated area north of Woodfordian boundary].

HYDROLOGY

W. T. BALMER, U.S. Geol. Survey. Chester County Water Use. Chester County water-use data are being collected for the U.S. Geological Survey State Water Use Data System (SWUDS). This data base will have the capability of showing connected water use as well as withdrawals and return data. ACD: 1986.

W. T. BALMER and **DREW DAVIS,** U.S. Geol. Survey. Hydrologic Investigation of the Ground Water Resources of Delaware Co., Pa. The study will provide specific hydrologic properties and water-quality data for the major aquifers in Delaware Co. ACD: June 1985.

A. E. BECHER, U.S. Geol. Survey. Ground-Water Resources of Cambrian and Ordovician Carbonate Rocks in the Valley and Ridge Province of Pa. ACD: Sept. 1986.

T. F. BUCKWALTER, U.S. Geol. Survey, and **M. W. SMITH** and **T. M. BERG,** Pa. Geol. Survey. Ground-Water Resources of Warren Co., Pa. An evaluation of the quality and quantity of the ground-water resources throughout the county is ongoing. Fracture trace mapping and revisions to geologic mapping by the Pennsylvania Geological Survey are near completion. ACD: Dec. 1987.

J. E. MANDUKE, III, Dept. of Environmental Resources, Bur. of Solid Waste Management. Hydrogeochemistry of Halogenated Contaminant Plumes. Compilation of site chemical data, computer modeling of fluorocarbons in groundwater at municipal solid waste sites, and geochemical breakdown interpretation of halocarbon pollutants. ACD: May 1986.

T. A. McELROY, Pa. Geol. Survey. Groundwater Resources of Cambria Co. The project will provide a description and inventory of groundwater resources in Cambria Co. Two adjacent basins, one mined, one not, have been gauged for 1½ years to determine the effect of mining on the hydrologic budget. ACD: June 1985.

T. A. McELROY, Pa. Geol. Survey. Groundwater Resources of Fayette Co. The project provides a description and inventory of groundwater resources in Fayette Co. It includes statistical analysis of the effect of coal and coal mining on groundwater chemistry and revised geology for western Fayette Co. ACD: In press.

T. A. McELROY and **J. D. INNERS,** Pa. Geol. Survey, and **BENJAMIN FOY,** Everett Borough Council. Municipal Water Supply from Abandoned Clinton Iron-Ore Mines, Everett, Bedford Co., Pa. ACD: 1986.

R. T. PAULSEN, U.S. Geol. Survey. Ground-Water Flow in the Carbonate Rocks of the Little Lehigh Creek Basin, Lehigh Co., Pa. ACD: Sept. 1986.

R. A. SLOTO, U.S. Geol. Survey, The Effect of Urbanization on the Water Resources of Eastern Chester Co., Pa. Study objectives include determination of impact of urbanization on ground-water quality, effects of sewering, and prediction of increase in runoff and peak flow with a rainfall-runoff model. ACD: Sept. 30, 1985.

E. L. WHITE and **GERT ARON,** Pa. State Univ. Hydrograph Model Study of Brandywine Creek, Pa. A hydrograph model study of the 287-square-mile Brandywine Creek watershed was made on low, medium, and high intensity rainfall events. The Hydrologic Engineering Center (HEC–1) and the Penn State Runoff (PSRM) Models were used to model the timing of subarea flood peaks and volumes at various points throughout the basin. ACD: 1985.

DON WILLIAMS, J. K. FELBINGER, and **P. J. SQUILLACE,** U.S. Geol. Survey. Washington Co. Water Resources Study. This study is being conducted to evaluate the surface-water and ground-water conditions throughout Washington County and to determine what effect deep coal mining will have on the water resources, particularly the ground-water resources in the unmined sections of the county. ACD: Mar. 1986.

J. H. WILLIAMS, U.S. Geol. Survey, and **L. E. TAYLOR,** Pa. Geol. Survey. Hydrogeology of the Glaciated Valleys of Bradford, Tioga, and Potter Cos., **Pa.** ACD: July 1986.

IGNEOUS AND METAMORPHIC PETROLOGY

BRUCE CUSHING, PATRICK BAKER, M. L. HILL, and **GEORGE MYER,** Temple Univ. Metamorphism and Deformation within the Martic Zone, Unionville and Coatesville Quads. Petrographic studies within the Octoraro Phyllite and Peters Creek Schist indicate at least two metamorphic and deformational events. The latest metamorphic/deformation event produced a large shear zone with left-lateral movement to the northeast. ACD: Aug. 1985.

A. L. HOERSCH, LaSalle Univ., and **W. A. CRAWFORD,** Bryn Mawr Coll. The Geologic History of the Mine Ridge, Southeastern Pa. In addition to the study of the metamorphic and structural history of the crystalline rocks of the Mine Ridge, their relationship to the early Paleozoic sedimentary rocks and to the adjacent crystalline rocks of the Honey Brook Upland are being examined. ACD: 1986.

M. S. RUTSTEIN, SUNY, Coll. at New Paltz. Low Grade Metamorphism of Martinsburg and Related Strata. Delineation and mapping of "illite" (illite + illite-smectite ± chlorite) isocrystallinity contours. Study area is being extended from southeastern New York into New Jersey and Pennsylvania to determine transition from foreland across Paleozoic metamorphic front(s). ACD: 1986.

C. D. WITANACHCHI, Bryn Mawr Coll. Deformational and Metamorphic History of the Wissahickon Schist, Norristown Quad., Pa. ACD: Oct. 1985.

PALEONTOLOGY

J. R. ANDERSON, JR., and **H. B. ROLLINS,** Univ. of Pittsburgh. Microgastropod Biofacies of the Upper Carboniferous System in the Northern Appalachian (Dunkard) Basin. This study is to update the taxonomy of the microgastropod species from the Upper Carboniferous marine units as well as determine the paleogeographical range of each species within 12 marine units in the Northern Appalachian (Dunkard) basin. ACD: Aug. 1985.

D. K. BREZINSKI, Md. Geol. Survey. Carboniferous Trilobites of the Northern Appalachian Basin [Ohio, Pa., W. Va., Md.]. Carboniferous (Mississippian and Pennsylvanian) trilobites are poorly known from the Appalachian region. The goal of this project is to describe trilobites present in Carboniferous strata of the Appalachians and their stratigraphic distribution. ACD: Dec. 1985.

W. F. KLOSE II, Paleontological Research Inst. Fossil Flora and Fauna of the Ross Anthracite in the Northern Anthracite Basin, Pa. Specimens from the Larksville mine fire and Loree Colliery, Larksville, Pa., and Alden Mountain, Glen Alden, Pa., have been collected and prepared for study and illustration. ACD: July 1986.

W. F. KLOSE II, Paleontological Research Inst. Fossil Floras of the Bernice Basin, Sullivan Co., Pa. A study of the fossil floras associated with the post-Pottsville sediments in the Bernice coal basin with correlation between the anthracite coal basins to the east and the bituminous coal fields to the west. ACD: 1990.

W. F. KLOSE II, Paleontological Research Inst. Fossils of the Anthracite and Semi-Anthracite Coal Fields of NE Pa. A revision to the succession of fossil floras and faunas of the anthracite and semi-anthracite coal fields of northeastern Pa. A monograph and collector's handbook is planned, illustrating the fine specimens in major U.S. museums. ACD: 1995.

W. A. OLIVER, JR., and **J. M. BERDAN,** U.S. Geol. Survey. Corals, Ostracodes and Biostratigraphy of the Keyser and Helderberg Limestones and Equivalents [N.Y., N.J., Pa., Md., W.Va., Va.]. Uppermost Silurian-Lower Devonian corals and ostracodes of the central Appalachians (NY to VA). Pennsylvania part of project is a study of the systematics and distribution (stratigraphic and geographic) of corals and ostracodes in the Keyser, Decker, and Helderberg Limestones. ACD: 1986.

D. C. PARRIS, N.J. State Museum. Biostratigraphy of the Martinsburg Formation in N.J. and Adjacent Areas [NW N.J. and Northampton Co., Pa.]. Biostratigraphic collections made for the National Park Service during 1984 will be continued and expanded. The principal objective is the use of graptolite zones for clarification and stratigraphy and structure in the region. ACD: 1986.

J. F. TAYLOR, R. W. TRAUT, P. J. FEDERINKO, Indiana Univ. of Pa. Trilobite Biostratigraphy of the Stonehenge Formation in Pa., Md., and Northern Va. A comprehensive description of the geographic and stratigraphic distribution of the Lower Ordovician trilobite faunas in the Stonehenge Formation. Lowest Stonehenge strata in northwestern Virginia have yielded trilobite species characteristic of the *Symphysurina bulbosa* subzone. ACD: Late 1986.

ALFRED TRAVERSE, Pa. State Univ., and **P. K. STROTHER,** Boston Univ. Evidence of Early Land Plants in Ordovician and Silurian Rocks of Central Pa. Upper Ordovician and Lower Silurian rocks of central Pennsylvania have yielded some hints about early land plant evolution. The authors continue to seek more evidence, especially in the Tuscarora and Bloomsburg Formations. ACD: Ongoing.

SEDIMENTOLOGY

HUE-CHUNG CHOU and **D. P. GOLD,** Pa. State Univ. Controls on Porosity and Bulk Density of Upper Paleozoic Sandstones [western and central Pa.]. Authors will measure porosity and bulk density of

Devonian through Pennsylvanian sandstones of the Allegheny Plateau and Valley and Ridge provinces, and interpret in terms of sediment source, sedimentation processes, diagenesis, and orogenesis. ACD: Aug. 1986.

JACK DONAHUE, R. C. CARLISLE, and **J. M. ADOVASIO,** Univ. of Pittsburgh. Historic Archaeology of Wells and Associated Material Found in Subway Construction [City of Pittsburgh, subway construction]. Sedimentology of water well fill found during Pittsburgh subway construction. Analysis is just beginning and will interface with results of study of cultural material found in wells. ACD: Summer 1985.

JACK DONAHUE, R. C. CARLISLE, and **J. M. ADOVASIO,** Univ. of Pittsburgh. Historical Archaeology of Rope Factory [City of Pittsburgh, near Allegheny Center]. Sedimentology and identification of organic materials associated with site. Material is coal, coal ash, or burned rope waste. ACD: Summer 1985.

JACK DONAHUE, TOM EAST, J. M. ADOVASIO, R. C. CARLISLE, and **GARY COOKE,** Univ. of Pittsburgh. Archaeology of Low Terrace, Schuylkill River, Berks Co., Pa. [Temple quad.]. Sedimentology, clay mineralogy, and depositional history of low terrace sequence and associated archaeological material. ACD: Summer 1985.

JACK DONAHUE, TOM EAST, J. M. ADOVASIO, R. C. CARLISLE, GARY COOKE, and **STEVE KENNEDY,** Univ. of Pittsburgh. Late Woodland Site on Low Terrace of North Branch, Susquehanna River, Catawissa, Pa. Sedimentology, clay mineralogy, and depositional history of Susquehanna River terrace, dated between 1,000 and 500 years B.C. ACD: Summer 1986.

ALBERT L. GUBER, Pa. State Univ. Facies Analysis of the Middle and Upper Silurian Formations of Central and Western Pa. A geochemical, paleontological, and sedimentological approach is being used to define facies sequences, prepare facies maps, and develop facies models for the Mifflintown, Wills Creek, and Tonoloway Formations. ACD: Continuing.

G. G. LASH, SUNY, Coll. at Fredonia. Turbidite Sedimentology of the Martinsburg Formation, Eastern Pa. Preliminary sedimentologic analyses of the Ramseyburg Member of the Martinsburg Formation suggest that it was deposited from sheetlike turbidites rather than as part of a classical submarine fan. ACD: Sept. 1986.

M. A. RENDINA and **WAYNE MARTIN,** Miami Univ., Ohio. Provenance, Petrography and Diagenesis of Some Selected Sandstones and Mudrocks of the Dunkard Group (Upper Pennsylvanian-Permian) in Ohio, Pa., and W.Va. Petrographic and paleocurrent studies reveal that the Dunkard basin received sediments from two sources: (1) a predominate southeastern foreland fold-thrust highland that consisted mainly of reworked sedimentary and low-grade metamorphic source rocks, and (2) from multicycle sedimentary strata occurring on the stable craton of the north. ACD: May 1985.

B. C. SEIDELL, Bryn Mawr Coll. Depositional History of the Upper Silurian Wills Creek and Tonoloway Formations, W.Va., Md., and Pa. Reconstruction of the Appalachian basin of West Virginia, Maryland, and Pennsylvania during the Upper Silurian using the approach of comparative sedimentology with known modern systems. ACD: Late 1986.

SUZANNE WEEDMAN and **A. L. GUBER,** Pa. State Univ. Facies Analysis and Petrography of the Upper Freeport Limestone [Jefferson and Clearfield Cos.]. Of special interest in this study are the role small lakes played in the drainage system of the late Allegheny alluvial plain and the paleoclimatic implications of continental carbonate sedimentation. Work began in spring 1985. ACD: 1987.

STRATIGRAPHY

T. M. BERG, Pa. Geol. Survey. Devonian-Mississippian Transition, Chapter 9 *in* The Geology of Pennsylvania. ACD: Summer 1985.

D. K. BREZINSKI, Md. Geol. Survey. Revision of Upper Mississippian Stratigraphy of Md. and adjacent Pa. and W.Va. Owing to the intertonguing nature of upper Mississippian strata of western Maryland and adjacent Pennsylvania and West Virginia, true stratigraphic relationships have become clouded and nomenclature confusing. The purpose of the project is to update stratigraphic terminology and document the lateral relationship of each unit. ACD: June 1986.

RICHARD DALTON, ROBERT CANACE, and **DONALD MONTEVERDE,** N.J. Geol. Survey, and **AVERY DRAKE** and **JOHN REPETSKI,** U.S. Geol. Survey. COGEOMAP—Subdivision of Cambro-Ordovician Kittatinny Supergroup of N.J. [Reading area, Lehigh Valley area]. The project is part of the greater COGEOMAP effort between the New Jersey Geological Survey and U.S. Geological Survey to remap New Jersey geology. This undertaking will be an attempt to reexamine type sections of Cambro-Ordovician carbonates in Pennsylvania and establish a correlation with New Jersey carbonates.

A. D. GLOVER, C. H. DODGE, J. G. PHILLIPS, J. R. SHAULIS, and **V. W. SKEMA,** Pa. Geol. Survey. TASIC (Temporarily Available Stratigraphic Information Collection) [western Pa.]. A continuing program for recording stratigraphic data on active coal and clay strip mines and collecting coal samples for analysis. The project will provide data for future mapping and regional resource evaluation. ACD: Ongoing.

J. L. JONES, York Coll. of Pa. Triassic Coal Deposits of York Co., Pa. The lignite-anthracite coal seams occurring in the New Oxford Formation of the county will be examined. Stratigraphic relationships, correlations, and chemical analyses will be examined. ACD: Nov. 1985.

E. F. KOPPE, Consultant. Correlation of Coal Strata between the Main Anthracite and Bituminous Coal Fields of Pa. [north-central Pa.]. The stratigraphy of isolated northern coal fields is being refined and the relations between basins clarified (in manuscript). Sullivan County coals correlate well with the anthracites of Lackawanna County. ACD: 1986.

S. T. PEES, Samuel T. Pees and Associates. Distribution and Geometry of the Whirlpool Formation Mapped as 70% Clean Sandstone in NW Pa. [Erie, Crawford, Warren, Venango, and Mercer Cos.]. Isopachous maps show distribution of the Whirlpool Sandstone, Medina Group (Facies 5 of Laughrey, 1984), in portions of five adjacent counties. The net effective sand is picked from gamma-ray curves of over 700 logs. ACD: Dec. 1985.

R. C. SMITH, II, and **J. H. WAY,** Pa. Geol. Survey. Seven or More Tioga Ash Beds in the Valley and Ridge of Pa. Outcrops within the Middle Devonian Tioga zone reveal at least seven correlatable ash beds, ranging from a millimeter to a few tens of centimeters in thickness. This horizon was originally recognized by Fettke (1931, Pa. Geol. Survey, Prog. Rept. 102B, p. 8). ACD: Continuing.

ANDREW WARNE and **G. R. McGHEE,** Rutgers Univ., and **JOHN DENNISON,** Univ. of N.C. Stratigraphic Analysis of the Greenland Gap Group and Lock Haven Fm. [Allegheny Front]. Temporal association of "Chemung" rocks from south to north along the Allegheny Front of Pennsylvania. ACD: June 1985.

STRUCTURAL GEOLOGY

P. S. BAKER, BRUCE CUSHING, M. L. HILL, and **G. H. MYER,** Temple Univ. Ductile Deformation and Retrograde Metamorphism within the Octoraro Phyllite. Evidence for a Shear Zone [Parkesburg Quad.]. By studying outcrops, oriented hand samples and oriented thin sections we have determined that the Octoraro Phyllite lies within a shear zone. Shear indicators reveal a subhorizontal, left-lateral movement with a NE-SW trend. ACD: June 15, 1985.

M. B. GRAY, Bryn Mawr Coll., and **R. P. NICKELSEN,** Bucknell Univ.

Slickensided Soil Fractures as an Indicator of Strain [primarily central Pa.]. Slickensided soil fractures (SSF) form in expansive soils and are preserved in the rock record. SSF may serve as strain indicators in conjunction with other strain markers. Formations studied include the Bloomsburg (Silurian), Catskill (Devonian), Mauch Chunk (Mississippian), and Lockatong (Triassic). ACD: 1986.

J. M. HULL, Rutgers Univ., Newark. Structures at the Termination of the Chalfont Fault, Pa. [SE Pa.]. Oblique sinistral slip on the Chalfont fault terminates in an anticline-syncline pair typical of fold-and-thrust belts. Mechanisms of deformation and displacement transfer are currently being studied. ACD: June 1987.

WARREN MANSPEIZER and **MARK LUCAS,** Rutgers Univ., Newark. Lower Mesozoic Structures: Narrow Neck between the Gettysburg and Newark Basins. Geologic mapping of the Jacksonwald syncline in the narrow neck shows the syncline to have characteristics typically found in foreland fold-and-thrust belts. Structures, e.g., cleavage, shear fractures, faults, and deformed clastic dikes, are being mapped. ACD: Sept. 1985.

RICHARD NICKELSEN, Bucknell Univ. Folded Roof Thrust and Its Overlying Imbricates in the Pa. Valley and Ridge [Kishacoquillas Valley and Seven Mountains including the following 7½ minute quads.: Allensville, Barrville, Belleville, Burnham, McAlevys Fort, Mt. Union, Newton Hamilton]. Strain disharmonies at the Coburn-Antes Gap detachment and in the Tuscarora Formation at Laurel Creek have been interpreted, respectively, as the folded roof thrust of the Cambro-Ordovician carbonate duplex and as ramp faults cutting up section from the roof thrust to the Wills Creek-Salina detachment. ACD: Late fall 1985.

V. J. PFAFF, Univ. of Cincinnati. Mechanisms of Folding in the Central Appalachians, Pa. ACD: Mar. 1986.

L. B. PLATT and **DANA HARRISON,** Bryn Mawr Coll. Strain Related to Folds in the Triassic of Eastern Pa. ACD: May 1985.

H. A. POHN, Project Chief, U.S. Geol. Survey. Structural Studies of Allegheny Plateau Using Remote Sensing Techniques. A report on disturbed zones as indicators of subsurface faults and possible hydrocarbon traps in the Valley and Ridge and the Appalachian Plateau provinces of Pennsylvania, Maryland, and Virginia has been submitted to the American Association of Petroleum Geologists for publication. ACD: FY 1986.

SAMUEL I. ROOT, Coll. of Wooster. Structural Geology of the Gettysburg Basin. ACD: 1986.

D. W. WATSON, Slippery Rock Univ. Fracture Study of the McConnell's Mill Gorge, Lawrence Co., Pa. A study of the relationships among gorge trends, joint sets, and tectonic stress. ACD: 1987.

REPORTS PUBLISHED

ADOVASIO, J. M., and **CARLISLE, R. C.**, 1984, An Indian hunters' camp for 20,000 years. Scientific American, v. 250, no. 5, p. 130.

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ARON, GERT, and **WHITE, E. L.**, 1984, Hydrograph model study of Brandywine Creek, PA [abs.]. Geol. Soc. America Abs. with Programs, v. 16, no. 6, p. 432.

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BAHAT, DOV, and **ENGELDER, TERRY**, 1984, Surface morphology on cross-fold joints of the Appalachian Plateau, New York and Pennsylvania. Tectonophysics, v. 104, no. 3–4, p. 299–313.

BARKER, J. L., 1984, Organochlorine pesticide and polychlorinated biphenyl residues at four trophic levels in the Schuylkill River, Pennsylvania, *in* Meyer, E. L., ed., Selected papers in the hydrologic sciences 1984. U.S. Geol. Survey Water-Supply Paper 2262, p. 25–31.

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Our data computerization efforts are not without a variety of difficulties and frustrations. These range from the problems of mastering the operational procedures, to the un-ending "bugs" which seem to infest each and every computer program and require endless hours of correction. And it is equally unnerving to be told shortly after delivery and installation of a computer unit that a new and highly improved model is now on the market.

Despite it all, we have no choice but to push forward with our efforts to utilize the most modern techniques to handle and utilize the wealth of geologic data for the benefits to the science of geology and the citizens of Pennsylvania.

Arthur A. Socolow

A RECIPE FOR COAL FLOWERS

The formula for developing crystal growths on coal and similar materials has been around for many decades and has been used in schools and science clubs for the edification of young and old. Periodically we receive inquiries for the procedure and we share it here, as we clipped it many years ago from a paper, for all who may be interested. While the ingredients are common, household items, we urge care in handling them.

The first recipe calls for 6 tablespoons salt, 6 tablespoons bluing, 6 tablespoons water, 1 tablespoon ammonia water. After thoroughly mixing, pour over clinker from the furnace, a piece of coke or a brick. After piece has been well wet with the liquid, drop on it a few drops of mercurochrome solution or red or green ink. Do not use any other solution in the mixture or you might get an adverse chemical reaction. After materials have been brought together a coral-like growth soon begins to appear on the clinker. This increases rapidly. It also tends to form on the edges of the dish and will climb up and over them unless the edges have been rubbed with vaseline. Addition of a little more ammonia water to the dish will produce more growth after the first has stopped. Or, the whole may be allowed to dry and then kept without further change.

The second recipe calls for 1 lump of hard coal placed in a bowl, 4 tablespoons salt, 2 tablespoons bluing, 3 tablespoons water, 6 drops mercurochrome. (Add these ingredients in the order mentioned.) A few drops of water once a week (on the side of the coal) after original mixture has been absorbed will keep it moist and growing. If the growth should go over the bowl do not put cut-off pieces in the drain, but place in the trash as the water will make it grow in the pipe. It is most interesting to watch it grow.

HUMOR(?) IN GEOLOGY

Courtesy of Tom Austin,
Austin Exploration Inc., Houston, TX

I could have worked in potential field geophysics, but I didn't have a magnetic personality.

I could have worked hard and become a seismologist, but I didn't want to make waves.

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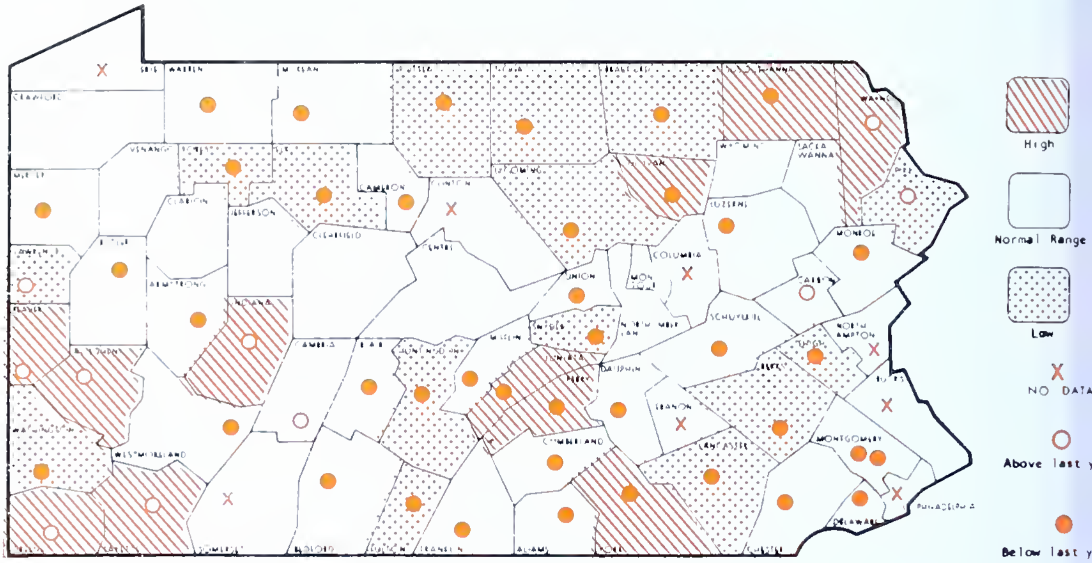

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ON THE COVER: The near-vertical streaks are Devonian age Venango sandstone along Pa. Route 59 beside Allegheny Reservoir, 0.2 mi east of Kinzua Dam, Warren County. The *Skolithos* fossils are common in clean sandstones that were deposited as offshore bars. The sandstone is important as an oil and gas producer. Photo by Tom Berg.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

VOL. 16, NO. 5 **OCTOBER, 1985**

FROM THE DESK
OF THE
STATE GEOLOGIST

SECURITY AND KNEE JERKS

Would the U.S. drop its military defense program if it were demonstrated that it is not economical? Probably not, since there is a consensus in our nation that national security is essential. Yet a recent new announcement indicates that another vital security component, the availability of domestic oil and gas, is receiving a major curtailment in the name of economic justification.

The nation's only commercial scale synthetic fuels plant, the Great Plains Coal Gasification Project in North Dakota, is scheduled to be shut down by its corporate operators because the federal government has decided to discontinue its financial underwriting since it has become cheaper to import oil than to manufacture synthetic fuels. This decision overlooks the fact that research and development of synfuels was intended not merely to combat the rising prices of oil and natural gas, but more importantly, to establish a security cushion for the U.S. to be able to take care of its essential oil and gas needs if cut off from foreign sources.

Even in the face of declining oil and natural gas prices and a temporary oil and gas "glut," the world is well aware of the questionable reliability of America's foreign sources upon whom we are again approaching a 40% dependency for oil and gas. Despite the fact that U.S. exploration and occasional discoveries persist, the continuing trend of oil and gas reserves in the U.S. is down! The availability of a technologically operated synfuel program is a security development which should not be measured only in dollars. And Pennsylvania, with its large resources of coal that is the new raw material for synfuels, has a significant stake in this issue. Science magazine (8/16/85) quotes Clifford W. Rackley on the federal curtailment, "We have proceeded in a knee-jerk reaction in the past. We are acting in a knee jerk fashion now."

Arthur A. Socolow

KEYSTONE LIME COMPANY, INC.

Making the Most from What's Available

Keystone Lime Company, Inc. selectively mines a nearly flat-lying limestone and sandstone sequence in the Allegheny Plateaus physiographic province in southern Somerset County. Here, Negro Mountain Anticline brings Mississippian age rocks to the surface in a southwest-northeast-trending topographic and structural high. Two quarries and one underground mine near Mt. Davis (Pennsylvania's highest elevation, 3213 feet) provide crushed stone and agricultural limestone for Pennsylvania, Maryland, and West Virginia.

The ancestral company was started around 1930 as a "burnt-lime" operation with its first quarry and 7 kilns (now abandoned) located near Niverton. The active Galley Quarry, located near the southeast corner of High Point Lake at Savage (lat. 39°46′33″N, long. 79°12′24″W), was developed in the 1950's. Selective mining of Mississippian-age strata provides multiple end-use products from the various rock types available. After removing Mauch Chunk red shale overburden, 8 to 10 feet of Deer Valley Limestone is selectively quarried for the production of agricultural limestone and PennDOT approved, Type A, Skid Resistance Level (SRL) L aggregate (SRL L aggregate can only be used in bituminous surfaces with average daily traffic counts of 1000 or less). This limestone is characterized as a light-gray calcarenite (clastic sand-sized limestone). Flint (1965) identified the calcite fraction as containing 36% clastic granular calcite, 33% detrital microfossils, and 26% microcrystalline cement, and designated this quarry as the type section for the Deer Valley Limestone. The limestone contains a quartz-rich layer of variable thickness at the top of the sequence.

Directly beneath the Deer Valley Limestone is the Loyalhanna Formation characterized here as a grayish-red, conspicuously cross-bedded quartzose limestone averaging about 40 feet thick. The Loyalhanna's uncommon red color, which is confined to southern Somerset County, is attributed to interstitial hematite and hematite coatings (Flint, 1965). This limestone is an important bedrock aggregate and railroad ballast source in western Pennsylvania. It provides most of the tonnage produced by Keystone Lime. It is recognized as important because of PennDOT's Type A, SRL H designation, which permits its use in bituminous road surfaces having daily traffic counts of up to 20,000. This sandy limestone has one of the highest coefficients of friction for crushed stone. It is second only to a few sandstones that have a SRL E rating. Both the Loyalhanna Formation and the Deer Valley Limestone are interpreted to represent a somewhat turbulent shallow marine environment of deposition which records a transgressive marine event (Flint, 1965).

Subjacent to the Loyalhanna Formation, the Burgoon Sandstone (Pocono Formation) is mined at the Galley Quarry principally as a high-friction aggregate source (SRL E). This uppermost part of the Burgoon sequence is generally characterized as a light-gray to light-greenish-gray, fine-to-medium grained sandstone containing some minor varicolored shales and siltstones (Figure 1). Mineralogically, the sandstone contains major quartz, minor mica, chlorite, feldspar, and trace pyrite. Ancient stream channels, visible in the 20-foot-high quarry faces, attest to a fluvial environment of deposition. Locally, a black shiny interstitial carbon or bitumen is present in some sandstone beds. Flint (1965) reported that Koppe studied a 1- or 2-inch-thick coal from this formation at Fairhope. There is also, apparently, a thin sedimentary hematite ore bed near the top of the Burgoon Sandstone. It was not observed in place, but is believed to be less than two inches thick. Some vague fossil replacements are visible, and this ore bed may be possibly related to a local unconformity between the overlying Loyalhanna Formation and the Burgoon Sandstone.

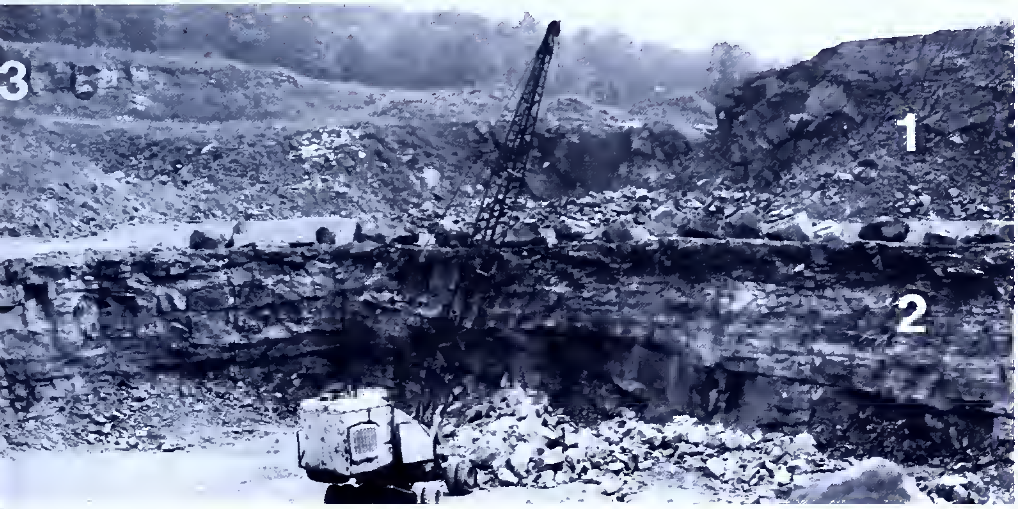

Figure 1. Burgoon Sandstone faces at the Galley Quarry of Keystone Lime Company, Inc. This south-looking view shows several fluvial channels in the 20-foot-high sandstone faces. 1 = Loyalhanna Formation, 2 = Burgoon Sandstone, 3 = Deer Valley Limestone.

Most of the available reserves of the Deer Valley and Loyalhanna Formations have been depleted from the Galley Quarry, which is now chiefly a source of high-friction aggregate (Burgoon Sandstone). However, the Eichorn Quarry, located about 2 miles south of Savage on Christner Hill (lat. 31°44′42″N, long. 79°12′24″W), has been developed in similar Deer Valley and Loyalhanna limestones (Figure 2). Large reserves are available from this location, as is the underlying Burgoon Sandstone, which is not presently being mined. State-of-the-art automated crushing and a computerized hot-mix plant are located on the Eichorn site. Only 5 people are required to run both plants.

The Peck Mine, located 1 mile northeast of Savage on the west-facing slope of Mount Davis (lat. 39°47′43″N, long. 79°11′37″W), is developed in the Wymps Gap Limestone. The mineable sequence of Wymps Gap is characterized as a medium bluish gray, medium-to-

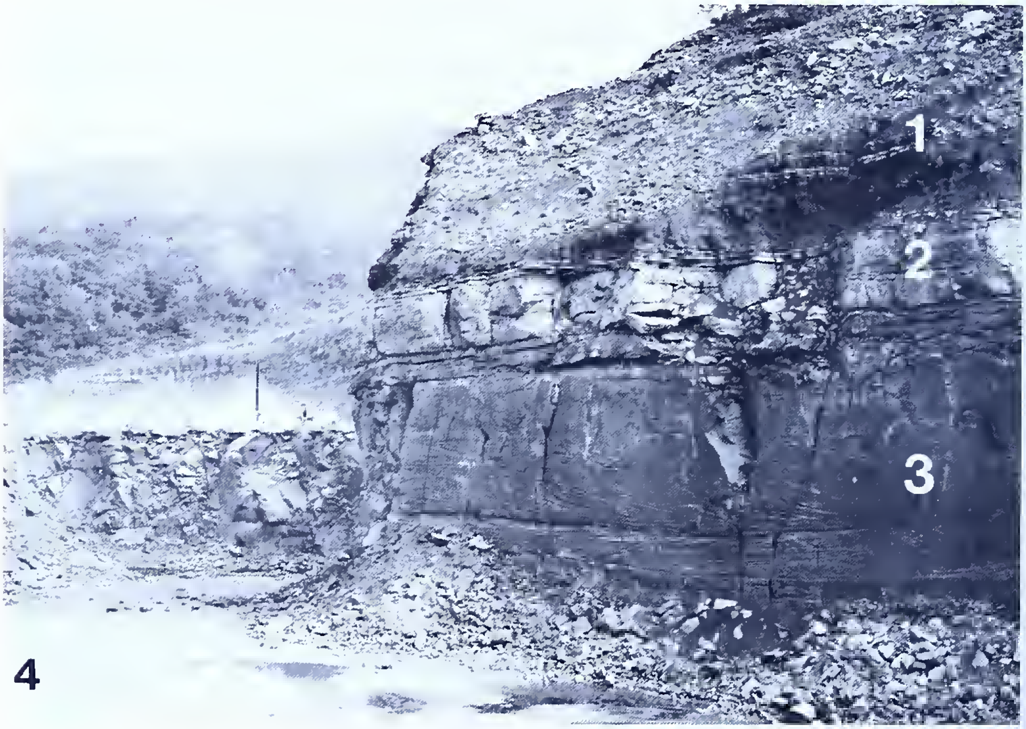

Figure 2. Quarry faces of the Eichorn Quarry of Keystone Lime Company, Inc. Notice the conspicuous trough and minor planar cross-stratification of the quartz-rich Loyalhanna Formation. The floor of the quarry is the upper part of the Burgoon Sandstone. 1 = Mauch Chunk Formation (overburden consisting of red shales, minor siltstones and sandstones), 2 = Deer Valley Limestone, 3 = Loyalhanna Formation, 4 = Burgoon Sandstone.

finely crystalline, fossiliferous marine limestone. Above and below this 10-foot-thick, thick-bedded limestone are fossiliferous shale and limestone interbeds. The most abundant fossils are brachiopods, but bryozoans, trilobites, and crinoids also occur. Hoskins and others (1983) further describe the fossil assemblage at this site. This limestone stratigraphically occurs about 80 feet above the Deer Valley Limestone. The Wymps Gap, Deer Valley, and Loyalhanna limestones are all correlatives with the Greenbrier Formation of West Virginia (Berg and others, 1983 and Flint, 1965). The underground room-and-pillar mine (rooms about 35 feet by 35 feet and pillars about 50 feet by 50 feet) removes about 8 feet of the basal, thick-bedded fossiliferous limestone as a source of high-grade agricultural material, but is worked only in the winter months.

In general, Keystone Lime's marketing area for aggregate, principally from the Loyalhanna, covers about a 30-mile radius, whereas the agricultural products, produced from the Deer Valley and Wymps Gap, stretch to about a 50-mile radius, and the top-quality, high-friction aggregate (SRL E), produced from the Burgoon Sandstone, reaches out the farthest, to about a 60-to-70-mile radius. Combined annual production of these operations is approximately 300,000 tons, with the majority coming from the Loyalhanna portion of the Eichorn Quarry. Innovative mining techniques and state-of-the-art processing plants assure a continued supply of quality construction and agricultural products for the Pennsylvania, Maryland, and West Virginia markets.

We thank Mark Folk, President, Keystone Lime Company, Inc., for his time and cooperation in preparing this article.

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OIL AND GAS BASE MAPS COMPLETED

As announced previously (Pennsylvania Geology, v. 16, no. 2, p. 12–13, April, 1985) the Pennsylvania Geological Survey, Oil and Gas Geology Division, is making available to the public a new series of 7½ minute oil and gas base maps. At the time of that announcement, the series included only the maps in the upper half of the oil and gas fields area of western Pennsylvania. The series is now complete, covering all of western Pennsylvania's oil and gas fields and the areas of central and eastern Pennsylvania where exploratory drilling has occurred. The new series is accessible as ozalid ("blueline") reproductions of standard U.S. Geological Survey 7.5-minute topographic maps overprinted with well symbols and identifying numbers. The topographic portion of each map is subdued to let the well information stand out, but is still legible on a blueline reproduction.

The 7.5-minute base maps replace, rather than supplement, the 15-minute series of base maps that have been sold through the State book Store since 1970. All of the old 15-minute maps, titled "Oil and gas well base map of the ... 15′ quadrangles" are now out-of-print and will no longer be sold by the State Book Store. The 7.5-minute maps are available on "open-file" at the Oil and Gas Geology Division in Pittsburgh.

When requesting the maps please provide the 7.5-minute topographic *map name* of each map desired. To determine map names refer to "Pennsylvania Index to Topographic and Other Map Coverage" published by the U.S. Geological Survey and available free of charge by writing to our Bureau offices or from the Branch of Distribution, U.S.G.S., 1200 S. Eads St., Arlington, VA 22202.

The Index to the new maps may be obtained by contacting the Oil and Gas Geology Division, 7th Floor Highland Building, 121 S. Highland Avenue, Pittsburgh, PA 15206, telephone number (412) 665–2155, between 8:00 AM and 4:00 PM weekdays.

Oil and gas base maps cost $3.40 per copy plus shipping costs and are ordered through A. H. Mathias & Co., Inc., 950 Penn Avenue, Pittsburgh, PA 15222 or by contacting the Division offices.

CHLORITE-REPLACED FOSSILS IN UNION COUNTY

by Jon D. Inners
Pennsylvania Geological Survey

Of the many types of fossil preservation the most interesting to the mineralogist is replacement. This manner of fossilization involves the solution of original skeletal substance (generally calcite or aragonite in the case of invertebrate shells) and the simultaneous deposition of some other mineral substance within the void thus formed. The medium of dissolution and deposition is highly mineralized water, either occurring within the interstices of unconsolidated deposits at shallow depths or in pores and fractures of deeply buried and rigidly indurated sedimentary rocks. In central Pennsylvania, the most common minerals replacing originally calcitic or aragonitic shells are quartz (in limestones), pyrite (in clay shales), and hematite (in ironstones and ferruginous limestones). Adding to this list of secondary minerals in fossils, the author recently discovered a rather unusual locality in northern Union County where invertebrate shells in the Lower Silurian Rose Hill Formation are replaced by a mixture of quartz and chlorite (a greenish, scaly mineral).

The "chloritized" fossils are found in a borrow pit at Nittany Mountain Campground, located on the north side of Millers Bottom Road (T-442) in White Deer Township, 4.6 mi west-northwest of New Columbia (41°02'57"N/76°57'12"W, Allenwood quadrangle; Figure 1). Nittany Mountain, one of several prominent anticlinal mountains which die out eastward across northern and western Union County, lies just to the north of the site. The owner of Nittany Mountain Campground, Mr. Jack Ficks, periodically removes shale from the pit for use in road paving and campsite foundations. He welcomes collectors and students, asking only that they check in at the office before proceeding to the pit.

Exposed in the borrow pit are poorly fissile, yellowish-gray and dusky yellow, fossiliferous clay shales containing a few lenticular interbeds of olive-gray, very fine grained sandstone. Fracture surfaces in both clay shales and sandstones have conspicuous coatings of bluish-black iron-manganese oxide and bright reddish-orange iron oxide. Bedding in the pit dips 48 degrees toward S4E on the south limb of the Nittany Mountain anticline. Many bedding surfaces exhibit faint, closely spaced nonmineralized grooves ("slickenlines")

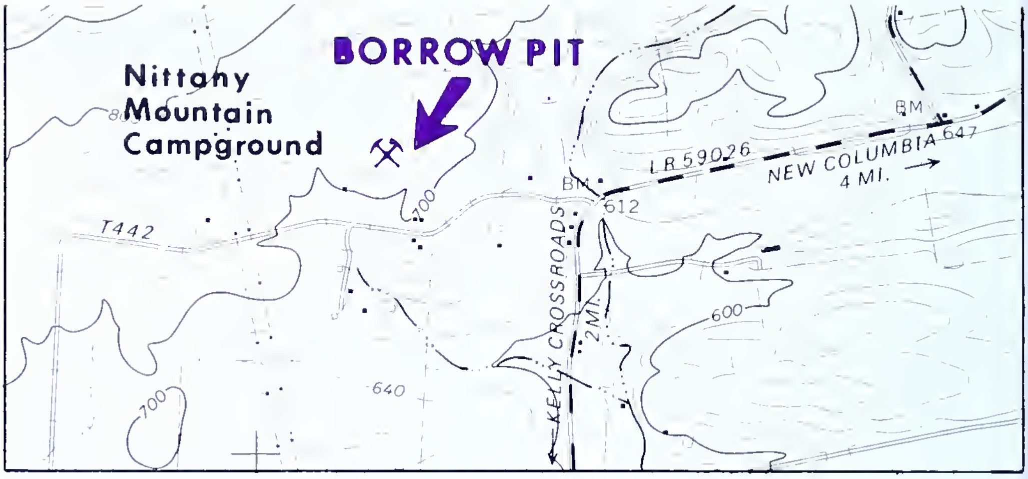

Figure 1. Location map.

formed by slippage of the shale layers past each other when the rocks were tilted and bent to form the Nittany Mountain anticline, approximately 250 million years ago. The pit lays open 150 feet of section, with the uppermost beds occurring approximately 350 feet below the top of the Rose Hill Formation.

The Rose Hill shales at Nittany Mountain Campground contain a profusion of marine invertebrate and trace fossils. Most abundant are small, distinctly lobed, zygobolbid ostracodes (especially *Bonnemaia* sp.) and tiny, needle-shaped and ribbed cricoconarids (*Tentaculites minutus*), both of which are clearly visible under a 10X hand lens. More readily discerned by the unaided eye are the numerous coelospirid brachiopods (*Eocoelia* sp.) and phacopid trilobites (*Liocalymene clintoni*) and the less common bivalves (*Nuculoidea* sp.) and strophodontid brachiopods (*Brachyprion* sp.). These invertebrate

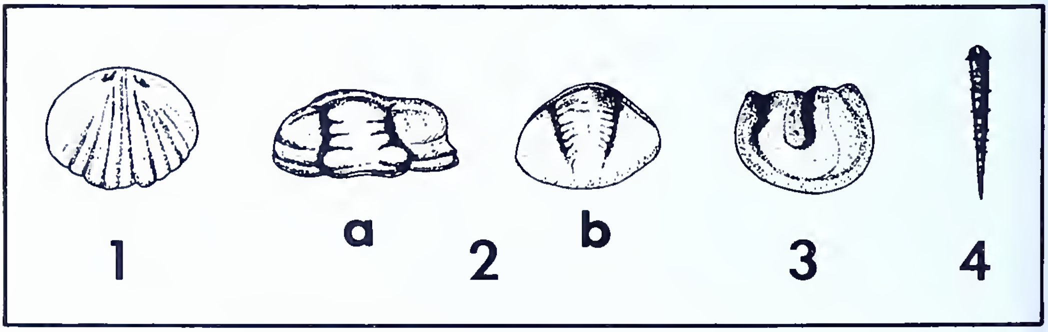

Figure 2. Common fossils from Rose Hill Formation at Nittany Mountain Campground. 1 = *Eocoelia* sp., X1.3; 2 = *Liocalymene clintoni* (Vanuxem), X1.2, a. cephalon, b. pygidium; 3 = *Bonnemaia* sp., X5; 4 = *Tentaculites minutus* (Hall), X4.

fossils, a few of which are illustrated in Figure 2, occur primarily as internal and external molds in the clay shales. Also prominent at several horizons in the pit is the horizontal trace fossil *Chondrites,* believed to represent the regularly branching feeding tunnels of a marine worm.

Nearly all of the invertebrate shells show complete or partial replacement of the original calcitic or aragonitic shell substance by a mixture of milky quartz and sparkly green chlorite. X-ray diffraction analysis indicates that the chlorite is a relatively iron-rich variety, probably 14A chamosite, according to the classification of Bayliss (1975) (R. C. Smith, II, and John H. Barnes, personal communication). The chlorite typically occurs as tiny (0.1 mm or less) flakes forming a reticulate mesh normal to the original shell surface, whereas the quartz is in subhedral crystals up to 0.5 mm in length that appear to post-date the chlorite mesh. Some of the quartz crystals have sharp, pyramidal terminations. In leached and weathered shale, chlorite weathers to reddish-orange iron-oxide which stains the surfaces of the fossil molds. Although many ostracode and cricoconarid shells are completely replaced by the quartz-chlorite mixture, it appears that most of the larger fossils—the brachiopods and trilobites, for example—are only partially replaced.

The yellowish-gray Rose Hill clay shales at the Nittany Mountain Campground pit originated from argillaceous sediments that accumulated in the quiet, moderately deep, rather poorly oxygenated (dysaerobic) marine shelf waters which existed here about 425 million years ago (Cotter, 1983). When first deposited, the sediments probably consisted of a complex suite of clay minerals—i.e. illite, kaolinite, smectite, chlorite, etc.—together with abundant silt-and-clay-size quartz. Slow and progressive alteration of the initial clay-mineral suite as a result of ion-exhange, dewatering, and increased heat and pressure during burial eventually produced a lithified clay shale composed almost entirely of illite, chlorite, and quartz (see Grim, 1968; Hunter, 1970; and O'Neill and Barnes, 1981). Chlorite-quartz replacement of the invertebrate shell material could have taken place at almost any time that formation waters were mildly reducing and nearly neutral (Krumbein and Garrells, 1952). Laughrey (1984) notes that authigenic, iron-rich chlorite formed during early stages of diagenesis in some Medina (Lower Silurian) sandstones of northwestern Pennsylvania. It is possible that the chlorite-quartz replacement found at Nittany Mountain Campground also occurred relatively early, prior to lithification, when iron-rich pore water was being expelled through burial compaction.

The author thanks Robert C. Smith, John H. Barnes, and Leslie T. Chubb for performing the X-ray diffraction analysis and Donald M. Hoskins for assisting in identification of the ostracodes.

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Mrs. Donna Snyder, Manager of the Pennsylvania Survey's Water Well Licensing and Data Program, on the occasion of her 20th anniversary with the Survey.

HISTORICAL MARKER COMMEMORATES EARLY SALT WELL IN CRAWFORD COUNTY

by John A. Harper

On May 17, 1985, the Pennsylvania Historical and Museum Commission unveiled a new historical marker at the side of state route 198 in Beaver Township, Crawford County, about 5½ miles west of Conneautville. The marker (Figure 1) commemorates the drilling of what appears to be the earliest salt-producing well in northwestern Pennsylvania, commenced in 1815. As something of an added attraction, the well also became a milestone in the history of the state's oil and gas industry. But this is not surprising—salt and petroleum production have had a very close relationship for over 200 years.

Oil and gas are certainly not new commodities in Pennsylvania. As early as 1748 the American travelogue of Peter Kalm, a former pupil of Linneaus, cited the occurrence of oil springs along Oil Creek in what is now Crawford and Venango Counties (Owen, 1975). The excellent "Map of the Middle British Colonies in America," an early mapping event in colonial America by Lewis Evans, showed the locations of these springs (Lytle, 1959). The springs were exploited by the American Indians, and later by the European settlers moving into or through the region, basically for medicinal purposes; the naturally occurring crude was purported to be a purgative and an effective treatment for rheumatism. Natural gas was recognized early for its value as a fuel ("illuminating gas), but it wasn't until the mid-1800's that oil became generally useful as a lubricant and for fuel.

The salt industry was very important in the history of oil and gas production. Techniques such as cable-tool drilling were developed by salt- industry personnel to meet growing market needs, and early salt-well drilling soon disclosed the association of crude oil and natural gas with brine water. The great "burning spring" near present-day Charleston, West Virginia, a salt well that caught fire, was considered a world wonder by Thomas Jefferson and George Washington. Several of the salt works at Tarentum in Allegheny County provided enough crude oil along with the brine waters to help establish a small petroleum refining industry in Pittsburgh. While observing the salt-drilling industry at Tarentum in Allegheny County, "Colonel" Edwin Drake learned the best method of drilling his now-famous well at Titusville.

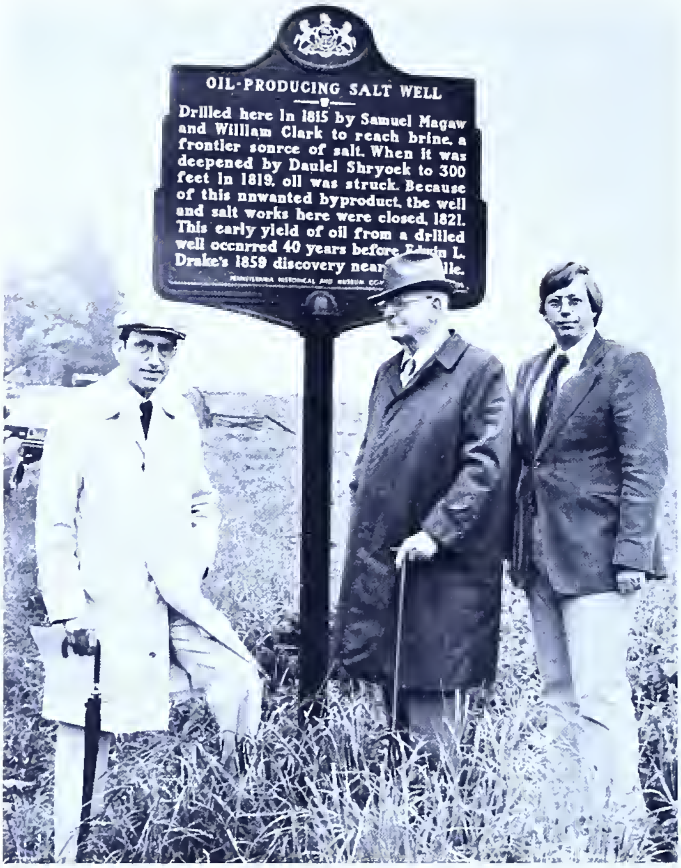
OIL-PRODUCING SALT WELL
Drilled here in 1815 by Samuel Magaw
and William Clark to reach brine, a
frontier source of salt. When it was
deepened by Daniel Shryock to 300
feet in 1819, oil was struck. Because
of this unwanted byproduct, the well
and salt works here were closed, 1821.
This early yield of oil from a drilled
well occurred 40 years before L.
Drake's 1859 discovery near lle.

Figure 1. Historical marker dedicated May 17, 1985 in Crawford County. Participants include (from left) Samuel T. Pees, who found the well, Walter Small, the last surviving founding member of the American Association of Petroleum Geologists, and John Harper. (Photo courtesy of Jorge Valdes, Samuel T. Pees and Associates.)

The salt industry was more important to early western Pennsylvania history than was oil and gas, however. With the American Revolutionary War, and the western expansion of the American settlements, came a need for cheaper means of obtaining salt than transporting it across country from Salina, New York. The growth of Pittsburgh from a military fortress to an industrial city created a major market for salt. The salt-trade routes from Salina crossed New York to Buffalo, across Lake Erie to Erie, Pennsylvania, from Erie to Waterford in Erie County, then down through northwestern Pennsylvania by way of French Creek to the Allegheny River (Pees, 1983). When salt was subsequently discovered in areas surrounding Pittsburgh, particularly at Tarentum and Saltsburg, the market for Salina salt decreased, as did the trade along the old routes. This lack of salt trade in and across northwestern Pennsylvania prompted the communities to develop their own sources of salt, and several drilling operations in the early 1800's. The following is excerpted from a recent publication by Pees (1983, p. 107):

> In 1815, Samuel B. Magaw and Judge William Clark of Meadville undertook the drilling of a salt well in southwestern Beaver Township (Allegheny Magazine, 1817). The well was located near what was later to be called Reed's Corners...the well had found salt water and was then at a depth of 186 feet. Thirty kettles for boiling the brine were put into operation. The yield was ten bushels of salt per day. Mr. Magaw died in 1816 and Mr. Daniel Shryock of Meadville entered the business and became the principal operator.
>
> In 1816, the well was deepened to 270 feet in the belief that the formation water would be more salty at depth...Plans to further deepen the well were put into effect. Either in later 1818 or in 1819, the well depth was reported to be 300 feet (History of Crawford County, 1885, p. 264). While the final total depth of the well is uncertain, at some point in drilling, presumably deeper than 270 feet, oil was struck in sufficient quantity to cause serious contamination of the brine. Due to the oil, the salt works foundered and were finally abandoned in 1821.

The oil in the Reed's Corners well presumably came from the "Venango Third sand" (Upper Devonian, Venango Group), one of the principal oil reservoirs of northwestern Pennsylvania. Oil from this reservoir has been produced in commercial quantities as far west as Vernon Township, Crawford County (Lytle and others, 1976). The Reed's Corner well was, unfortunately for the operators, ahead of its time. Salt was selling for about $11 per 5 bushels (Pees, 1983), making the daily production of the well worth about $22. Crude oil, on the other hand, was considered a nuisance at that time. Had the well been drilled 20 years later, the owners would have been able to sell the oil; 40 years later they may have made a fortune.

The Reed's Corner salt well was again located in 1982 by the diligent field work of Sam Pees of Samuel T. Pees and Associates, Meadville. The well is situated on the Edgar T. Miller farm, in a small tributary of Middle Branch Creek (Figure 2), a part of Conneaut Creek drainage system. The 3-foot diameter wooden conductor pipe is visible under the water, but no other sign of the old salt works is apparent. Although the hole was plugged, the farmer constructed a wooden fence around the site to keep his cows from getting stuck in the mud at the surface (Figure 3).

The Crawford County historical marker is the second of geological interest to be unveiled by the Pennsylvania Historical and Museum

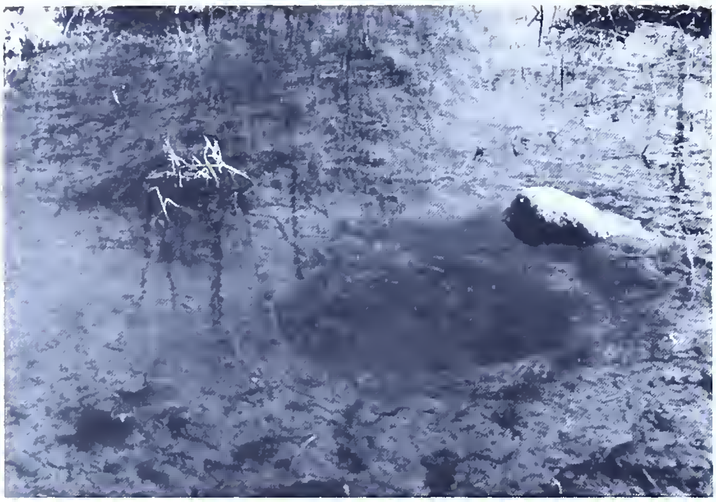

Figure 2. The well head is under water, but the 1983 photo shows the three-foot diameter wood conductor pipe (surrounding the darker circle of the well hole on the creek bottom) (from Pees, 1983).

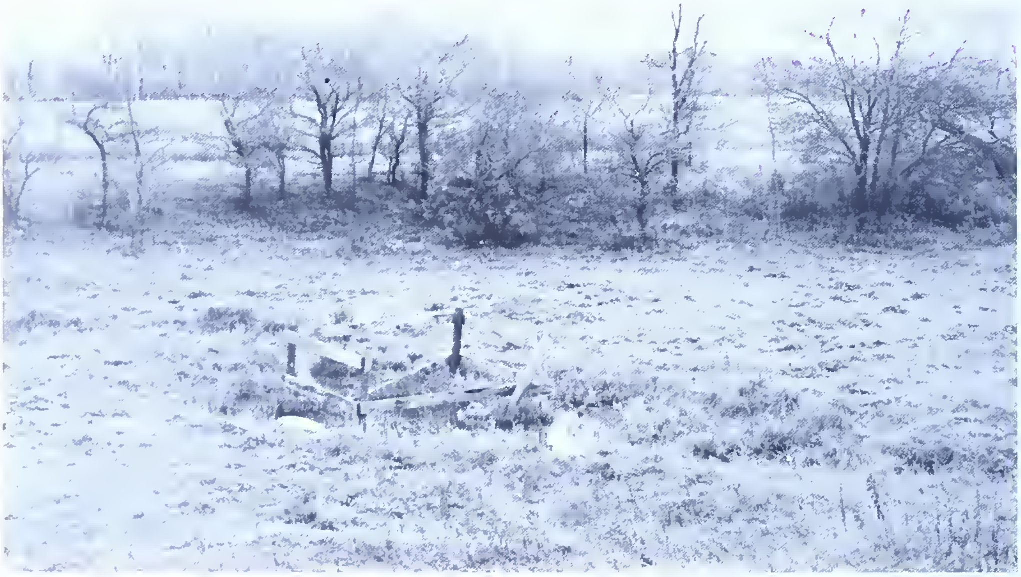

Figure 3. A later (1984) photo of the well site shows the fencing erected by the farmer, Mr. Edgar T. Miller, to keep his cattle from stumbling into the open hole. (Photo courtesy of Jorge Valdes, Samuel T. Pees and Associates.)

Commission in as many months. The first marker, concerning the Pittsburgh coal seam, was unveiled in Pittsburgh on April 18. This is encouraging for geological historians who feel that historical markers commemorating important geological features and events in Pennsylvania have been sorely lacking. It is to be hoped that these two markers represent only a first step in rectifying a troubling oversite.

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Lytle, W. S. (1959), *Introduction to bedrock and oil geology of northwestern Pennsylvania and the great Oildorado,* 24th Annual Field Conference of Pennsylvania Geologists Guidebook, Titusville, p. 12-36.

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Owen, E. W. (1975), *Trek of the oil finders: A history of exploration for petroleum,* American Association of Petroleum Geologists Memoir 6, 1647 p.

Pees, S. T. (1983), *Early oil and gas exploration to 1879 in western Crawford County, Pennsylvania,* Earth Sciences History, v. 2, p. 103-121.

WHEN MEXICO SHOOK, PENNSYLVANIA JUMPED

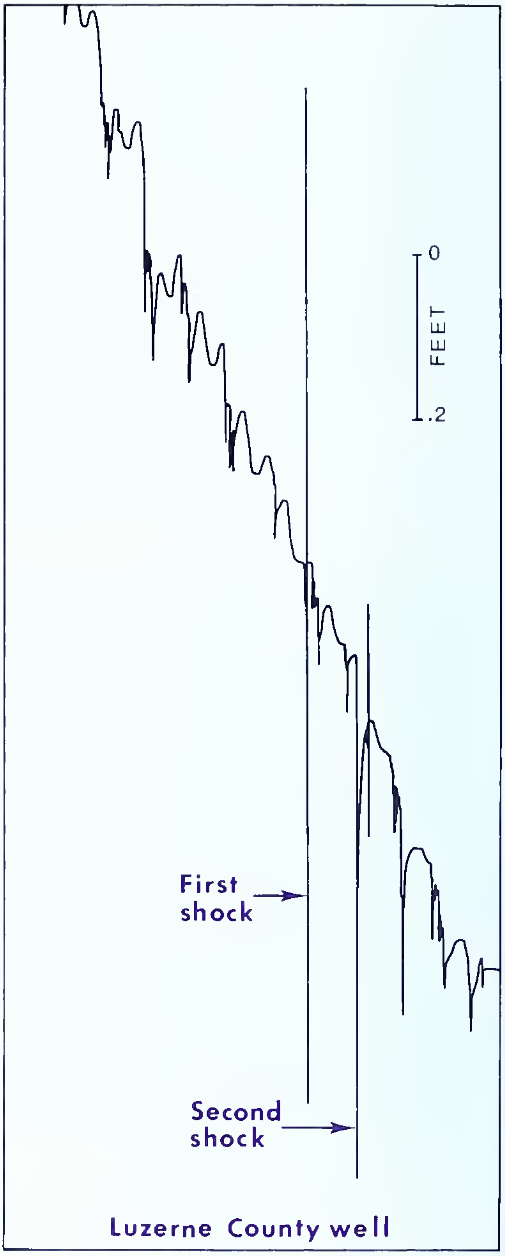
A September 19th survey of continuous water level records on 24 observation wells in the Susquehanna River Basin revealed that in 12 of those Pennsylvania water wells the earthquake shocks are clearly identified by sudden, short jumps in the water level. Those jumps are clearly shown on the water level recording tapes which are operating at each observation well; two of those tapes have been reproduced here on the accompanying figures. On each tape there is a sharp jump for both the first and second major earthquake shocks in Mexico, spaced about a day apart.

The following table of observation wells shows the extent of the quake related water level jump in each well:

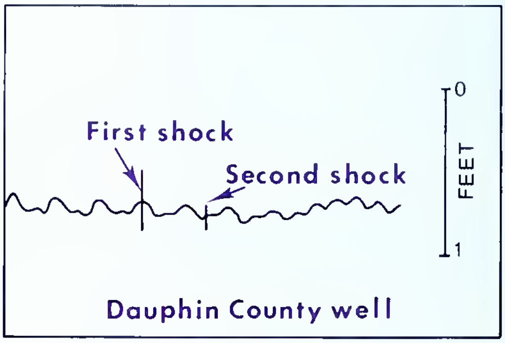
County	*Well Number*	*Jumps*
Adams	AD-146	.05 ft.
Centre	CE-118	.69
Clinton	CN-1	.06
Dauphin	DA-350	.35
Franklin	FR-332	.3
Fulton	FU-93	.2
Huntingdon	HU-301	.16
Juniata	JU-351	.4
Luzerne	LU-243	1.22
Snyder	SN-130	.05
Susquehanna	SQ-61	small
York	YO-180	.1

To understand the basis of the water level jump, consider a drinking straw half filled with water. If you pinch the lower half containing the water, the water level in the straw will rise while pinched. Similarly, when the earthquake occurred, the rocks surrounding each of the water wells were momentarily expanded, which in effect "pinched" the well hole causing the water in the well to rise momentarily. This is not a new or unknown phenomenon; we observed the same thing when the big Alaskan earthquake took place in 1964 near Anchorage.

The observation well-program is a continuing one in Pennsylvania consisting of 65 wells and co-sponsored by the Water Resources Division of the U.S. Geological Survey and by DER's Bureau of Topographic and Geologic Survey. The wells are serviced and monitored by the U.S. Geological Survey, which also retains the water level records for each well since its installation. Such records provide a basis for long range evaluation of water level conditions throughout the Commonwealth.



Luzerne County well



Dauphin County well

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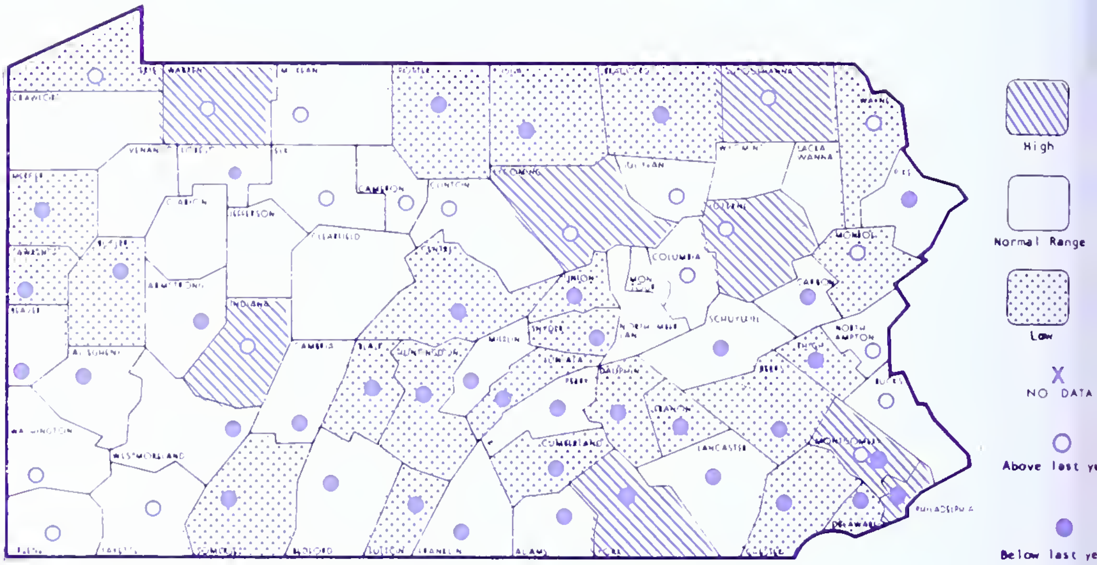

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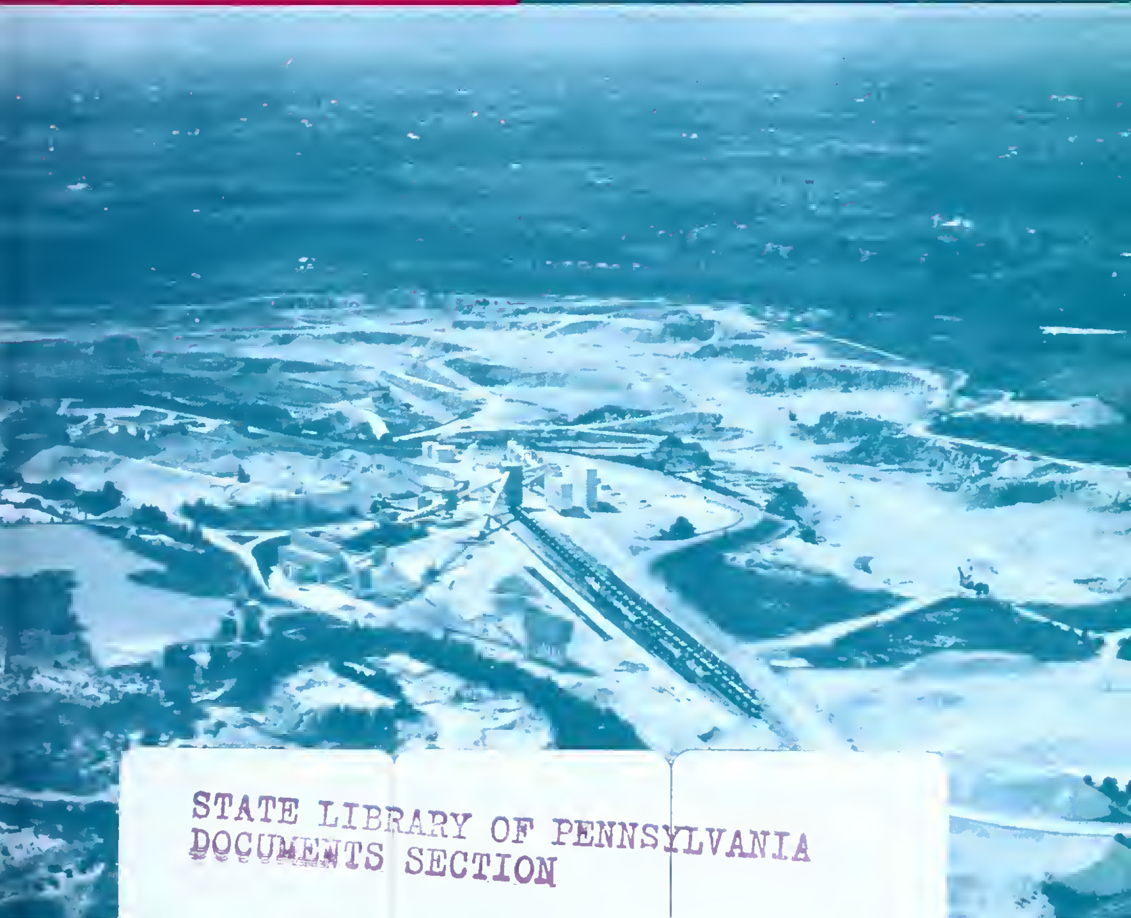

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ON THE COVER: Aerial view of one of Pennsylvania's outstanding mineral operations, the Hanover Quarry of the Bethlehem Mines Corporation. Located in Adams County, 3 miles NW of Hanover, the quarry produces agricultural carbonates, fluxstone, lime, railroad ballast, and construction aggregate. 50-car unit train in center of photo provides scale.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

VOL. 16, NO. 6 **DECEMBER, 1985**

FROM THE DESK
OF THE
STATE GEOLOGIST

MAPPING AGAIN PAYS OFF

The recent flurry of concern and investigation of abnormally high concentrations of naturally occurring radon gas in certain areas of eastern Pennsylvania again points up the value of comprehensive geologic mapping prior to the occurrence or recognition of serious geologic problems.

Because the Pennsylvania Geological Survey has over the years geologically mapped the Reading Prong and adjacent areas in considerable detail, and because members of our staff were nearing completion of a multi-year study of uranium occurrences in the Reading Prong, we were able to provide immediate guidance and assistance to radiation and health authorities when the radon problem was discovered. Our geologists were able to define the geographical and geological boundaries of the area that require detailed radon measurements and health evaluation.

Had there not been the prior investment of scores of man years in conducting the geologic mapping of that region, the necessary geologic guidance could not have been produced upon instant demand. This is just one other example of several that have been cited in this column over the years of the value of systematic geologic and minerals resource mapping. It is a reminder and lesson which reinforces the wisdom of the Pennsylvania Geologic Survey's ongoing programs of systematic mapping of our geologic environment.

Arthur A. Socolow

GROSS MINERALS

a force in the fine phyllite fillers field

Gross Minerals Corporation, a producer of asbestos-free, "talcum-fine" sericite, and a custom milling operation, is located on a railroad siding in Aspers, Adams County, Pennsylvania. The company began in 1957 as Summit Mining, and has operated under current management since 1977. They have mined sericite ore from the north and south Mickley open pits near Mt. Hope in Hamiltonban Township, Adams County since 1965.

GEOLOGY AND MINING. As mapped by Fauth (1978), the Mickley pits are located in a greenish-gray, lustrous phyllite occurring be-

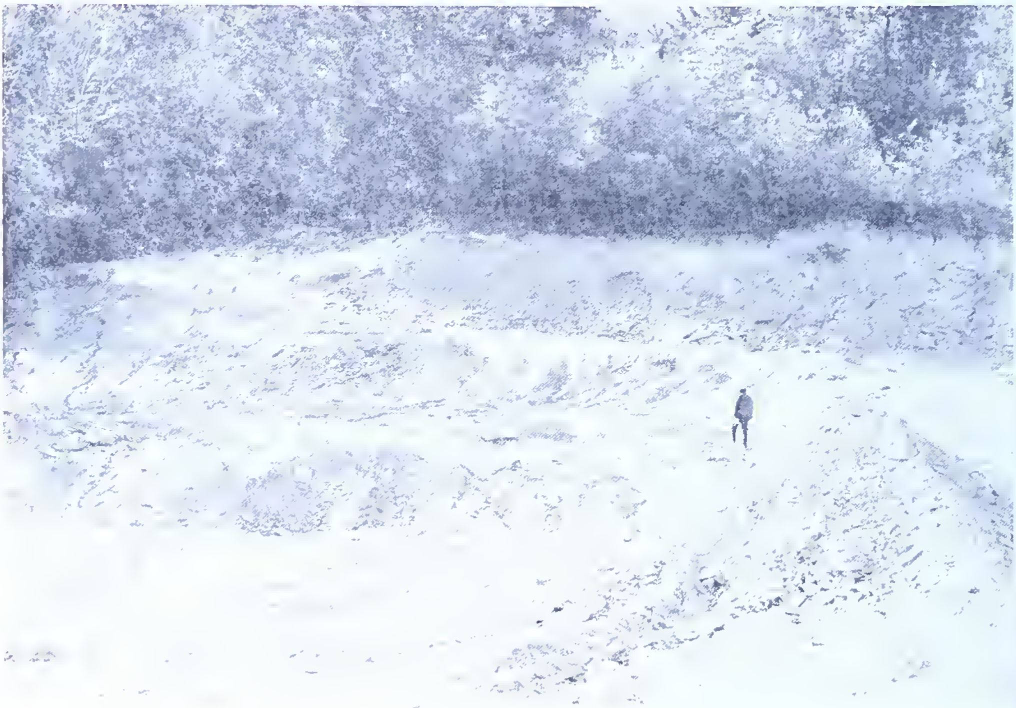


Figure 1. The new Mickley north pit looking west which is developed in a light-green sericite-rich phyllite. Schistosity dips towards the reader. Economic geochemist for scale. Notice ore stockpile on the right.

tween metabasalt and metarhyolite members of the Precambrian Catoctin Formation (Figure 1). In the vininity of Mt. Hope, Fauth mapped the phyllite zone as being about 200 feet wide at the surface. Potential ore reserves appear to be substantial, based on Fauth's mapping. Schistosity, which locally appears to parallel compositional layering, is oriented N42°E, 26°SE in the Mickley north open pit, and is more nearly horizontal in the eastern portion of the older, southern pit. The phyllite may represent a shear zone, or possibly a pyroclastic unit making the transition from quiescent basaltic lava flows to more violent rhyolitic eruptions. Locally, relict, strained cataclastic textures are elongated along the well-preserved schistosity. Quartz veins are rare, except near the extreme northwest edges of the two pits.

X-ray diffraction data indicate that the standard product (Ser-X #325) consists of major muscovite and quartz and trace feldspar and chlorite. A lilac-colored rock, that grinds pink, contains even greater amounts of muscovite. Malachite occurs locally as thin films along schistosity in both the north and the south pits, and may be responsible for an older test adit nearby.

Mining is subcontracted and consists of overburden stripping, drilling, blasting, ripping, loading, and hauling. Selective color sorting and mining is done in the pit. About 1,500 to 2,000 tons of ore is delivered to the plant three or four times per year. The haulage distance from the pit to the plant is about 22 miles.

MILLING. The mill was designed from the ground up by John E. Murray, Operations Manager, and draws on his many years of experience in the grinding business. Major features and components include a primary jaw crusher, an 8-million-B.t.u. drier that reduces the moisture content of the ore to less than 0.5% before fine grinding, a 400-hp, 10-foot-diameter ball-mill, a 125-hp fan (the source of a closed-air-classification system), and semi-automated packaging and handling (Figure 2). Product size is governed by gyrator speed and baffle plates. Gross Minerals produces three differently sized end-products; 88% passing the 325-mesh sieve (Ser-X #200), 96% passing (Ser-X #325), and 99% passing (Ser-X #400).

The custom grinding of about 4,000 tons of various products for other companies accounts for about half of the mill's annual output. A separate custom-grinding silo is maintained to help ensure purity of those products. Some of the more interesting products ground by Gross are rutile for white pigments, magnetite for coal-cleaning plants, and recycled refractory bricks. By reducing the

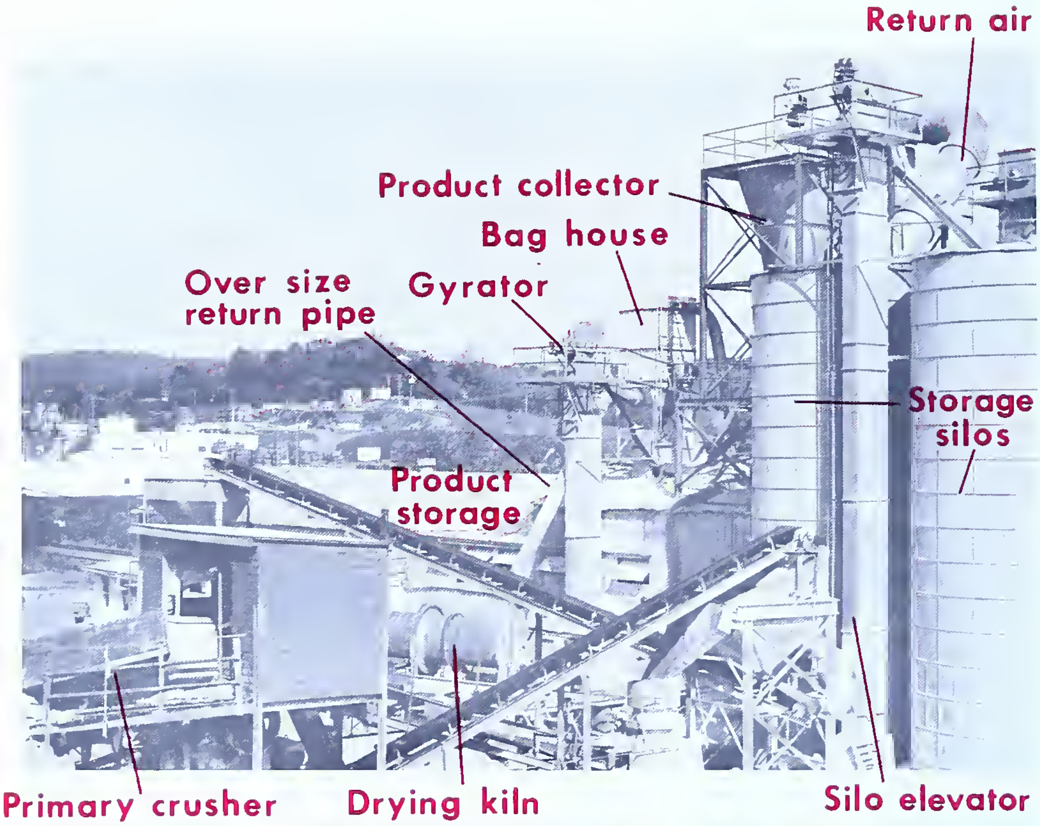


Figure 2. Overview of the Gross Minerals Corporation milling complex.

capital that would be required for each of these industries to set up a grinding mill, Gross Minerals helps reduce the consumer costs for a wide variety of mineral-related products.

MARKETING. The ability to deliver a consistent product on short notice has been a key to the success of Gross Minerals. Having about 60% of the potential U.S. market within a 300-mile-radius is another. By diversifying their sales into a variety of markets, they have avoided the often alluring snare of depending on a single, large-tonnage customer. At present, Gross Minerals' biggest market is for fillers in plastics manufactured for the automotive industry, accounting for about one fourth of sales by volume. This use helps to reduce foreign oil imports while yielding stronger, more thermally resistant plastics.

The second largest use of this sericite is for a carrier used in the manufacture of insecticides and fungicides. The sericite reduces the amout of chemicals that must be applied, and possibly extends the active life of the chemicals by decreasing runoff from rain. Some of this material is undoubtedly used in the wide-spread apple orchards of Adams County.

With a ground color between very light gray and yellowish gray, the product also finds use in paints. As an inert, non-sticking or non-clogging powder, it can be found in most major brands of fire extinguishers. It is also used as a filler in joint cements, pipe enameling, tires, rubber products, automotive undercoating, cement, and porcelain, as a dusting agent in roofing products, rubber molds, and metal patterns in foundries, as an abrasive and cleaner, as a protective coatings on wires.

CONCLUSIONS. Gross Minerals Corporation is a behind-the-scenes industry that makes life a little more safe, easy, comfortable, and economical. Its products make agricultural chemicals more effective, gives paint toughness and scrubbability, prevents sticking in both molds and finished products, retards combustion, and replaces and conserves more expensive petroleum-based products.

We thank Mr. John E. Murray, Operations Manager, for his unreserved explanations and time.

Reference

Fauth, J. L. (1978), *Geology and mineral resources of the Iron Springs area, Adams and Franklin Counties, Pennsylvania,* Pennsylvania Geological Survey, 4th ser., Atlas 129c, 72 p.

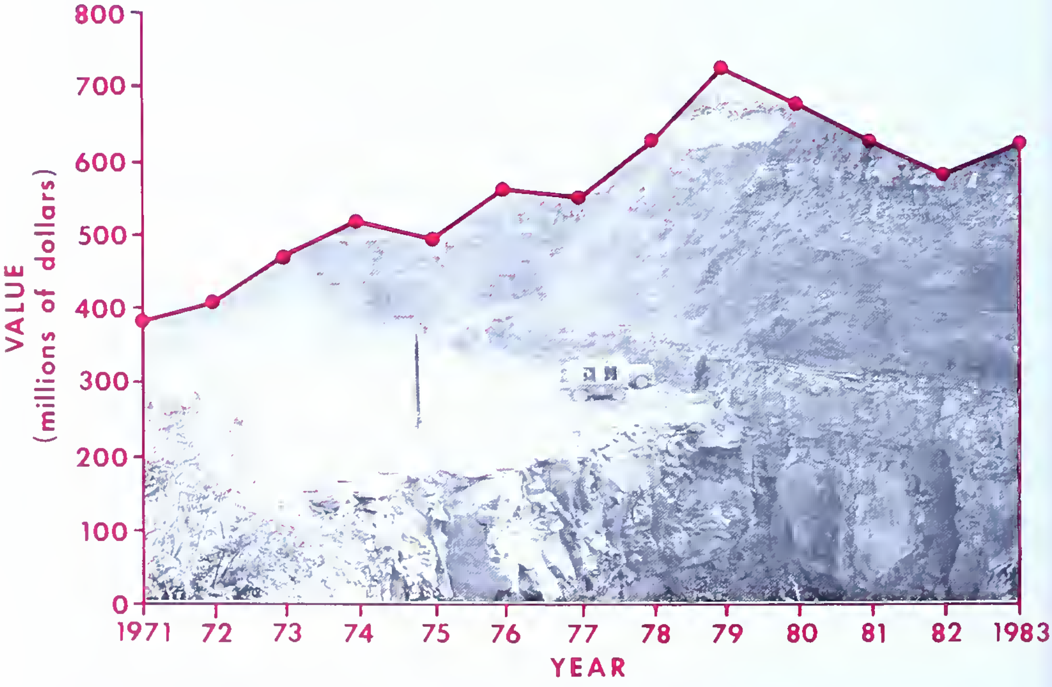
NEW DIRECTORY OF INDUSTRIAL MINERAL PRODUCERS

If it doesn't grow, and it doesn't burn, then it must be part of Pennsylvania's $600 million plus per year nonfuel minerals industry. In recognition of the need of mineral producers and mineral consumers to find each other, as well as for planners to design proper land use, our Information Circular 54 has been updated and given a completely new format. This revised edition includes about 700 mineral producers listed by commodity and county. In addition to listing the name and address of each known producer, we have expanded the primary data table to include the telephone number, the type of operation (quarry vs. underground mine), the name of each operation, the producing formations, the products manufactured (such as agricultural limestone, dimension stone, railroad ballast, etc.), and comments, including references to other more detailed published data.

This 165-page report features an 8½″ x 11″ format and includes location maps of selected commodities, such as agricultural minerals, clay and shale mined for brick manufacturing, and limestone mined for cement manufacture. A comprehensive index and an easy-to-read 1:500,000 scale commodity-coded location map of the state are also included.

The report is product oriented, designed to guide the consumer to the producer who can fill a need. This should benefit both producers and consumers in identifying the wide variety of raw materials available in Pennsylvania, and in finding a market for these raw materials.

Information Circular 54, *Directory of the nonfuel-mineral producers in Pennsylvania,* by Sam W. Berkheiser, Jr., John H. Barnes, and Robert C. Smith, II, is available at the State Book Store, 20 S. Third Street, Harrisburg. If ordering by mail, send a check payable to the Commonwealth of Pennsylvania for $5.75 (add 34¢ sales tax if sent to Pennsylvania address) to the State Book Store, P.O. Box 1365, Harrisburg, PA 17105.



Value of Pennsylvania's recent nonfuel-mineral production compiled from U.S. Bureau of Mines' Yearbooks.

AMES OR NOT AMES?

An ambiguous Conemaugh marine zone at Ebensburg

by Keith B. C. Brady, John A. Harper, and Jon D. Inners
Pennsylvania Department of Environment Resources

While the Conemaugh Group of western Pennsylvania has few minable coal seams and well deserves its early geologic name, the "Lower Barren Coal Measures," it makes up for a lack of economic importance by the presence of four thin, remarkably persistent marine zones that are of great stratigraphic utility. These marine horizons—from oldest to youngest, the Brush Creek, Pine Creek, Woods Run, and Ames—are now recognized as being "key beds" in unraveling the complex stratigraphy of the coal-bearing Pennsylvanian rocks of the main bituminous coal field (Dodge, 1983). The youngest, or stratigraphically highest, of the Conemaugh marine zones—the Ames—is also the most widespread, thought to be recognizable as far east as Wilkes-Barre in the northern anthracite field (Chow, 1951). According to current usage, the top of the Ames marks the top of the Glenshaw Formation, the lower of two units comprising the Conemaugh Group. (The base of the Glenshaw is defined as the top of the Upper Freeport, or E coal). In addition to serving as important stratigraphic markers, the Conemaugh marine zones also provide excellent fossil collecting at many localities in western Pennsylvania.

A significant new exposure of a marine zone, purported to be Ames, has recently been unearthed in the eastern part of the main bituminous coal field at Ebensburg in central Cambria County. The outcrop is situated at an elevation of approximately 2090 feet a short distance north of U.S. Route 422 adjacent to an athletic field at Bishop Carroll High School, 0.8 mile west of the center of Ebensburg (40°29′12″N/78°44′20″W, Ebensburg quadrangle). This marine zone has been identified as the Ames because of its occurrence—620 to 640 feet above the Lower Kittanning, or B, coal (extensively mined beneath Ebensburg) and approximately 440 feet above the Upper Freeport coal (Walter Shutty, personal communication 1985; McCulloch and Deul, 1973). The latter figure represents a marked eastward increase in the thickness of the

Glenshaw Formation from the approximately 330 feet typical of the Pittsburgh area (see Johnson, 1929).

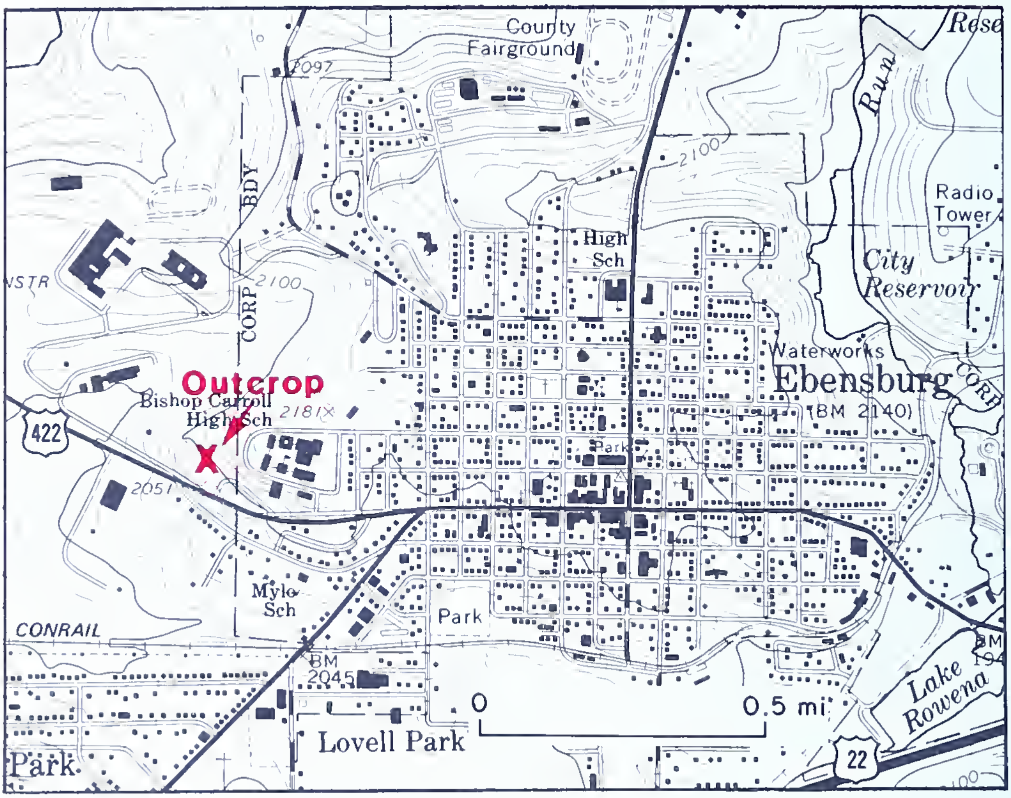


Figure 1. Location Map.

The excavation at Bishop Carroll High School exposes a stratigraphic thickness of about 20 feet, including what appears to be the uppermost part of the Glenshaw Formation and the lowermost part of the overlying Casselman Formation (Figure 2). In the middle of the section is the marine zone, 2.7 feet thick and including a 10.5 inch bed of dark gray, silty limestone. The limestone bed consists of a fine grained lower portion and a shelly, highly fossiliferous upper part that has a sharp, undulating basal contact (Figure 3). Crossbedded quartzose sandstone at the top of the excavation presumably is part of a thick sandstone sequence that caps the prominent hill on which Ebensburg is built (see Butts, 1905). These rocks were deposited as sediments about 310 million years ago during a Late Pennsylvanian transgressive-regressive episode which is preserved here as estuarine or lacustrine siltstone (base), open-marine limestone and shale (middle), and delta distributary or fluvial sandstone (top).

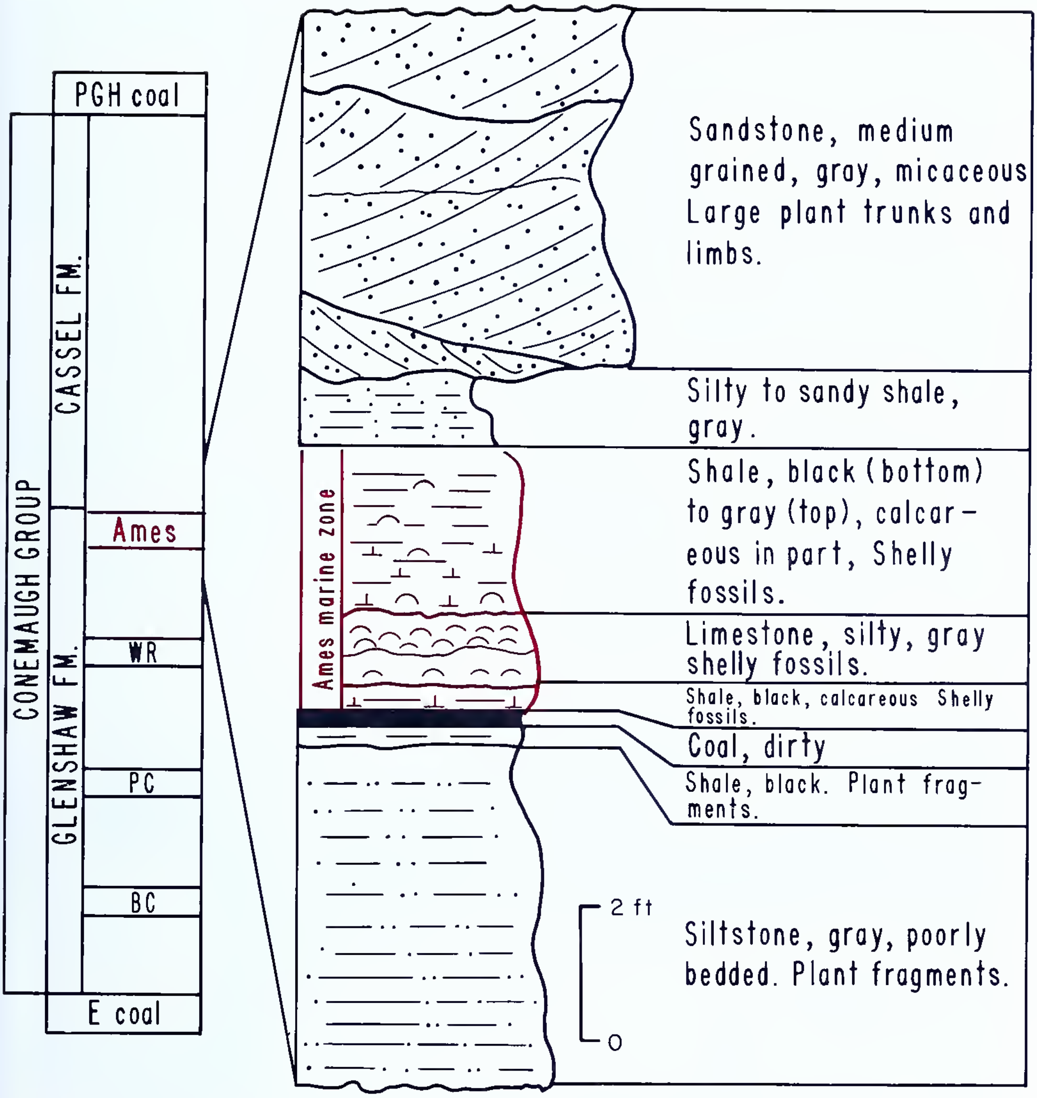

PGH coal
CONEMAUGH GROUP
CASSEL FM.
GLENSHAW FM.
Ames
WR
PC
BC
E coal
Sandstone, medium grained, gray, micaceous Large plant trunks and limbs.
Silty to sandy shale, gray.
Ames marine zone
Shale, black (bottom) to gray (top), calcareous in part, Shelly fossils.
Limestone, silty, gray shelly fossils.
Shale, black, calcareous Shelly fossils.
Coal, dirty
Shale, black. Plant fragments.
2 ft
0
Siltstone, gray, poorly bedded. Plant fragments.

Figure 2. Columnar section of the Conemaugh Group with an enlarged portion showing possible position of Bishop Carroll exposure in the section.

Fossils are very abundant at several horizons in the exposed section. Within the marine zone gastropods (9 species), bivalves (8 or more species), and brachiopods (5 or more species) are the dominant invertebrates, but the most interesting faunal elements are the species of agglutinated foraminifera and the *Petalodus* teeth (Table 1). The latter belong to a long-extinct type of pavement-toothed shark (order Bradyodonti of the class Chondrichthyes) in which the distinctive, low cusp or flat-crowned teeth were an adaptation for crushing hard-shelled mollusks and other shell-fish (Colbert, 1980).

The *Petalodus*-bearing shark probably resembled modern rays in having a broad depressed body and enlarged pectoral fins (Romer, 1966). Profuse plant remains occur in the sandstone at the top of the section and in the siltstone and shale (below the thin coal) at the base. Plant fossils in the sandstone are casts of large trunks and limbs, whereas those in the finer grained, lower beds are mostly seed-fern leaves and small, unidentifiable fragments.

There is an interesting problem associated with the identification of the marine zone at this locality. Based on the physical evidence, as explained earlier, the unit should be the Ames marine zone. The fossils, however, suggest that the marine unit is older than Ames. Of the 29 fossil forms identified from this locality, 8 are not well enough preserved for specific identification, and 18 are geologically long-ranging, typically found throughout the Allegheny and Conemaugh groups. (One, *Neochonetes granulifer,* was reported by Sturgeon and Hoare, 1968, as occurring only in the Ames; however, Harper has collected this species in the Brush Creek and Pine Creek units as well). Of the remaining 3, *Chonetinella plebeia* occurs only in the Brush Creek and Pine Creek (or Cambridge) units in Pennsylvania, Ohio and West Virginia, and *Amphiscapha*

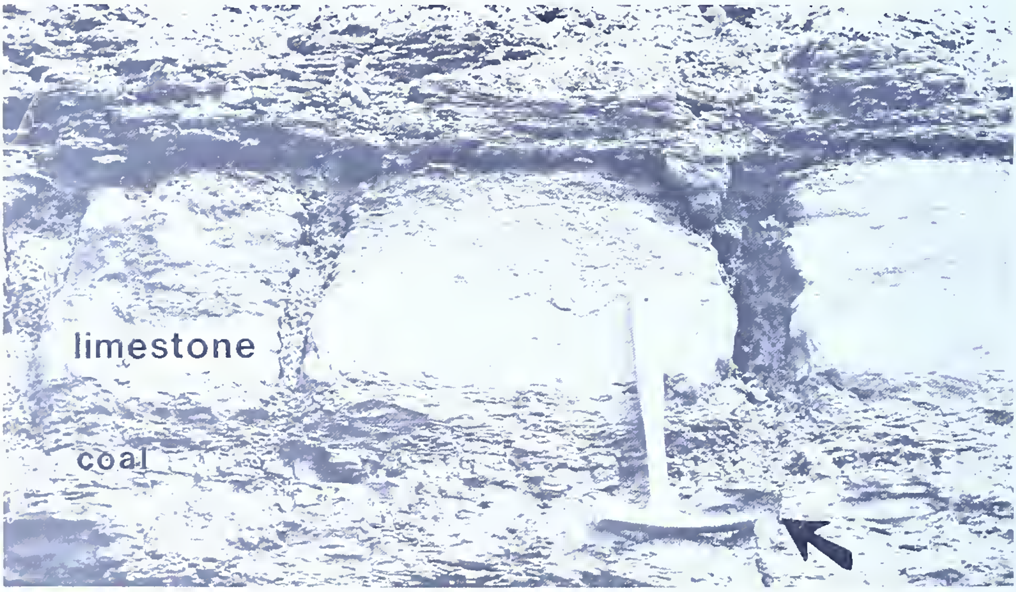


Figure 3. **Close-up view of Ames(?) marine zone and underlying non-marine strata, showing two textural subdivisions of limestone separated by uneven contact. Note vertical, solution widened joints in limestone (strike N45E) that pass into hairline fractures in shale (arrow). Hammer is 11 inches long.**

Table 1. Fossils in the Conemaugh Group marine zone at Bishop Carroll High School.

- Foraminifera
  - *Tolypaminna* spp.
- Coelenterate
  - *Stereostylus* sp.
- Brachiopoda
  - **Derbyia crassa* (Meek and Hayden)
  - *Chonetinella plebeia* (Dunbar and Condra)
  - **Neochonetes granulifer* (Owen)
  - unidentifiable productacean
  - **Crurithyris planoconvexa* (Shumard)
  - *Neospirifer* sp. indet.
- Bivalvia
  - **Nuculopsis croneisi* Schenck
  - **Nuculopsis girtyi* Schenck
  - **Paleyoldia stevensoni* (Meek)
  - **Phestia bellistriata* (Stevens)
  - **Parallelodon* sp. cf. *P. obsoletus* (Meek)
  - *Dunbarella?* sp.
  - *Acanthopecten?* sp.
  - **Astartella concentrica* (Conrad)
- Gastropoda
  - **Euphemites vittatus* (McChesney)
  - **Pharkidonotus percarinatus* (Conrad)
  - **Knightites (Cymatospira) montfortianus* (Norwood and Pratten)
  - *Amphiscapha cattiloides* (Conrad)
  - *Trepospira (Trepospira) sphaerulata* (Conrad)
  - **Glabrocingulum (Glabrocingulum) grayvillense* (Norwood and Pratten)
  - **Phymatopleura brazoensis* (Shumard)
  - **Strobeus paludinaeformis* (Hall)
  - **Strobeus primogenius* (Conrad)
- Cephalopoda
  - **Pseudorthoceras knoxense* (McChesney)
  - *Metacoceras?* sp.
- Echinodermata
  - Crinoid columnals
- Chordata
  - **Petalodus* (sharks' teeth)

*Geologically long ranging species

catilloides and *Trepospira (Trepospira) sphaerulate* are not positively known from rocks younger than the Pine Creek. (Price, 1914, listed *Amphiscapha catilloides* from the Ames of Preston County, West Virginia, but his identification is questionable). In addition, some of the other gastropods listed tend to occur in the Ames as distinctive variations of their typical forms. For example, *Glabrocingulum (Glabrocingulum)*, a moderately trochiform snail, tends to develop turreted whorls in the Ames. In fact, the subgenus approaches the related subgenus, *Glabrocingulum (Ananias)* in gross form (moderately high turreted shells). Only one specimen found at the Cambria County locality shows this tendency toward disjunct coiling, and that to a mild degree. *Knightites (Cymatospira) montfortianus* has coarse, nodose costae where it occurs in the Allegheny and lower Conemaugh rocks. In the Ames the costae increase in number and decrease in strength (probably representing a separate species). This variation was not observed in the Cambria County specimens.

Lithostratigraphically, the rocks at this locality appear to be the Ames marine zone and associated strata. This does not appear so clear from the biostratigraphic evidence. There has been no report of faulting, folding or tilting which could cause an apparently expanded section, so that it appears unlikely that the marine zone could be Brush Creek, Pine Creek, or Woods Run. Assuming the rock is truly Ames, then we shall have to revise our knowledge of the biostratigraphic utility of the fossil species discussed above. As is often the case in geology, more questions are raised than answered during research. This is a problem that will require more study in the future.

The authors thank Walter Shutty (BethEnergy Corporation), Thomas A. McElroy, and James G. Phillips for providing geologic information on the Ebensburg area.

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SURVEY ANNOUNCEMENTS

ENVIRONMENTAL GEOLOGY FOR LAND-USE PLANNING

Having been out of print for a number of years, *Environmental Geology for Land-Use Planning* has recently been reprinted. This 44-page publication, originally prepared in 1972 by Alan R. Geyer and William G. McGlade, defines environmental geology and its important contribution to building development and land utilization. It contains a lengthy list of subject references to guide the reader in further studies of environmental geology.

Published as Environmental Geology Report 2, the booklet is available by mail from The State Book Store, P.O. Box 1365, Harrisburg, PA 17105 for $3.20 or across the counter at the bookstore location, 20 South Third Street, Harrisburg for $2.60. Pennsylvania residents add 6% sales tax and checks should be made payable to the "Commonwealth of Pennsylvania".

AN ADAMS COUNTY COPPER-GOLD MINE

DOOMED TO FAILURE

by D. T. Hoff, State Museum of Pennsylvania
R. C. Smith, II, Pennsylvania Geological Survey

Gold fever, an overpowering psychological phenomenon, often produces highly irrational thinking. The thought of immediate wealth often results in mining and milling "ore" at a financial loss. The operators of the Hunterstown copper-gold mine were infected with a mild strain of this malady, and clearly violated Hunt's First Law of Mineral Deposits, which states that "...mines that are not close to deposits are not very satisfactory."

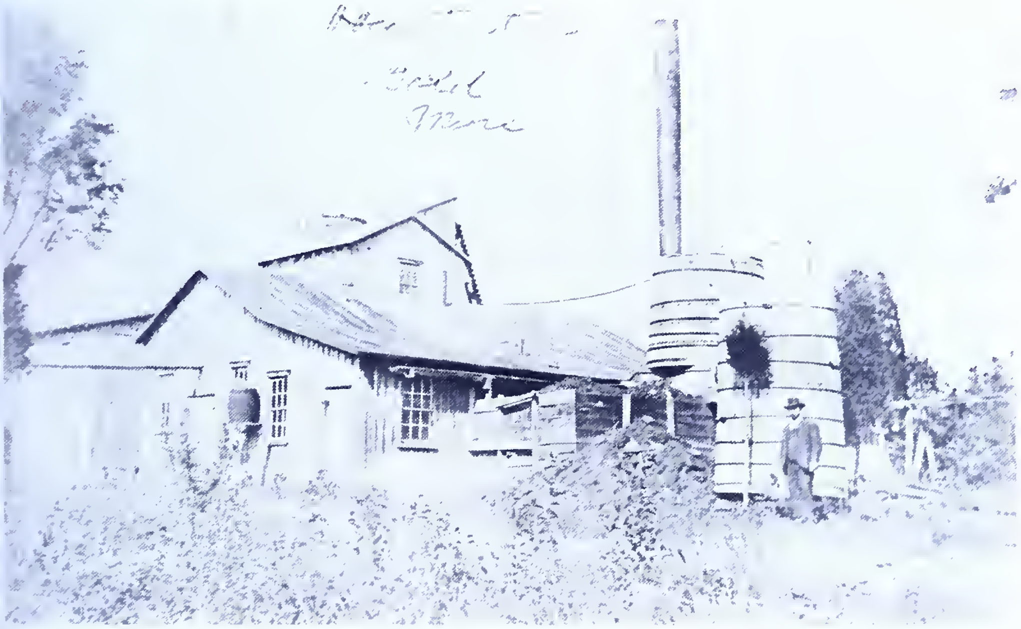

Figure 1. **The Reliance Mining and Milling Company's Hunterstown gold mine circa 1905. View to northwest shows Paris Erb and crusher building with conveyor in rear and elevated railroad from inclines on right. Courtesy of Edith Criswell.**

The first copper mining venture reported near Hunterstown was one by Galloway Bros. in 1884 (Sheely, 1886). The *Gettysburg Times* (1952) reported that Paris Erb first opened the Hunterstown copper-gold mine (Figures 1 and 2) 0.5 mile north of Hunterstown on the John Little property in 1885, and that some rock was shipped to Dillsburg before the operation closed. It was also reported that the Reliance Mining and Milling Company, Inc., reopened the mine in 1905 and dug an incline at an angle of 35° to a depth of 245 feet. Ore, said to assay at $90 per ton (based on prices of that date), was crushed on the property under the direction of Paris Erb, general manager and mining engineer, and the foreman, Martin Harman. The Reliance Mining and Milling Company was reported by the Gettysburg Times to have been incorporated in the Arizona Territory on Nov. 18, 1905 with a $250,000 stock offering. M. L. Davis of Lancaster was listed as president and work proceeded with 20 men working "around the clock."

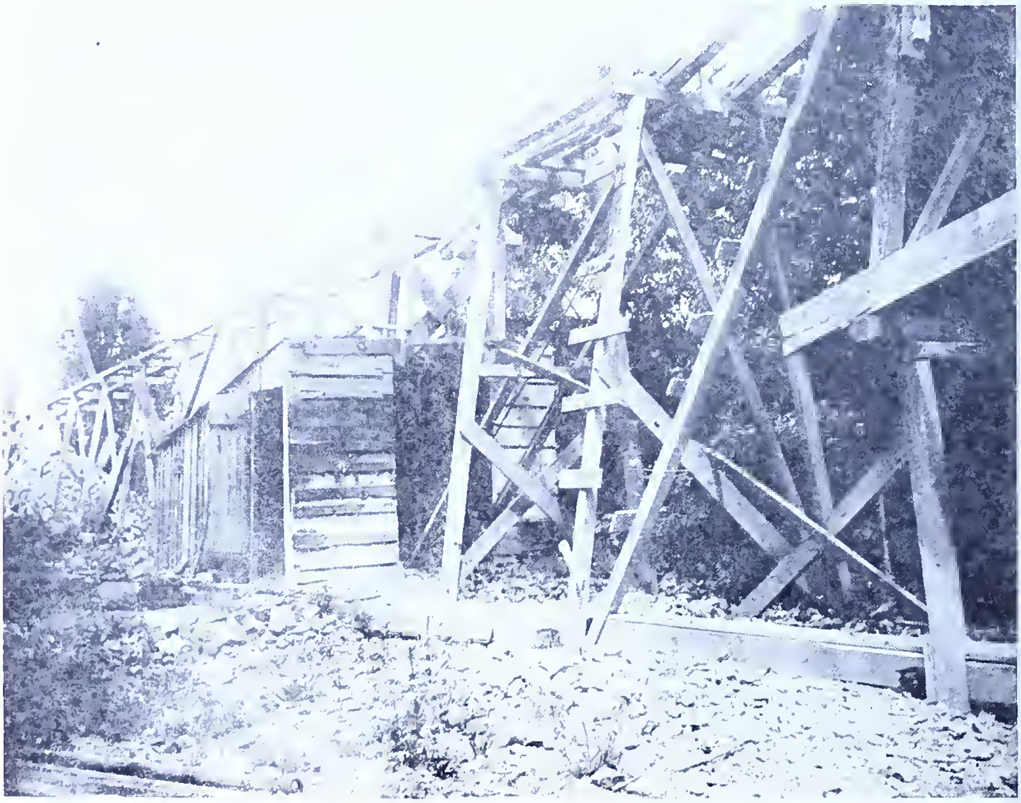

Figure 2. Inclined shaft headframe for the Hunterstown mine and elevated railroad to the mill, circa 1905. View to the north from a point to the east of Figure 1. Photo courtesy of Jay Lininger.

Stose (1932, p. 138) noted that "An incline descends 200 feet westward at an angle of 60°, and at the time of visit the prospect was equipped with hoist, crusher, and other machinery. The incline, however, was not open to inspection." The senior author entered the mine in 1955 and observed that the upper section of the mine was developed as a pair of inclines connected by a cross-cut. The southerly incline has two short, side drifts. Both inclines follow relict sedimentary bedding that dips approximately 30° to the west-northwest (Figure 3).

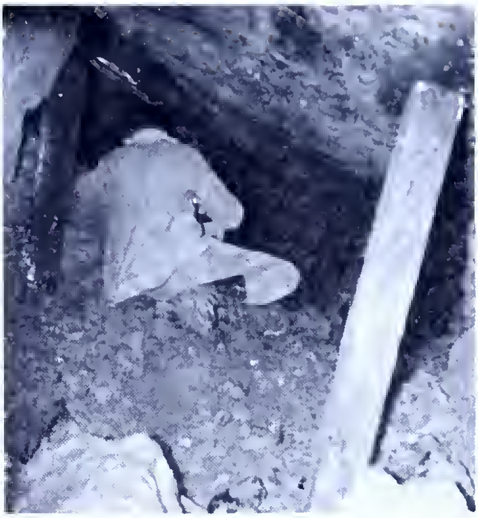

Figure 3. View inside Hunterstown copper-gold mine in 1955 showing the dip of bedding in the roof.

Copper mineralization on the dumps occurs in epidote-rich skarn (lime-bearing silicates) rather than the porcelain-like hornfels (baked shales). The only copper minerals identified were minor amounts of green to bluish-green chrysocolla and very sparse malachite. Analyses of a high-graded composite revealed the presence of only 0.54% copper, 0.012 oz gold/ton, and 0.01 oz silver/ton. A shallow open cut is located east-southeast of Red Bridge Road (Figure 4). J. P. Minard (1968) reported from less than 0.0006 up to 0.13 oz gold/ton in hand samples from this open cut. Similar occurrences lie 2.2 miles north-northwest near Plainview (Smith and Hoff, 1977), and 6.6 miles south-southwest at the former Campbell's quarry near Gettysburg (Hoff, 1978).

Although the mine was opened to produce copper, Allen Harman, son of the foreman, is reported (*Gettysburg Times*, 1952) to have noted native(?) gold streaks in the copper ore. Following this, mercury amalgam plates were added to the milling circuit to recover gold. Mr. Harman reported that he once pulled one pound of gold amalgam off with his hand, but gold was never shipped from the property.

Mrs. Allen Harman (personal communication, 1984) reported that she can remember the Hunterstown mine buildings in 1909 and that children entered the mill sheds and found bottles of mercury which they poured onto their hands to watch the heavy liquid roll around on their palms.

Edith Criswell (personal communications, 1984) reported a mine-roof collapse that occurred about 1910 when her father, Robert Englebert, was working in the Hunterstown mine with Hayden Camper, and that some of the mill concentrates may have been shipped from Granite Hill Station. She also stated that the mine buildings were still present prior to its final closing in 1916, when her husband-to-be, Vernie Criswell, and William Matthews were the last two men to work in the mine. According to Mrs. Criswell, activity at the Hunterstown mine ceased and resumed several times during the 1905-1916 period.

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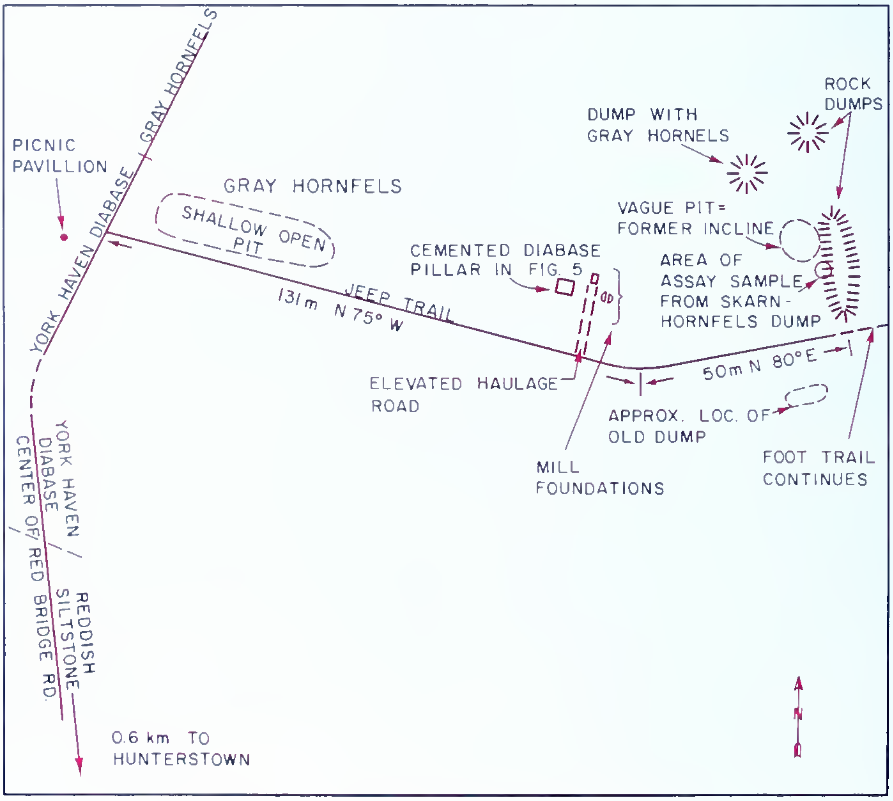

Figure 4. Hunterstown mine area.

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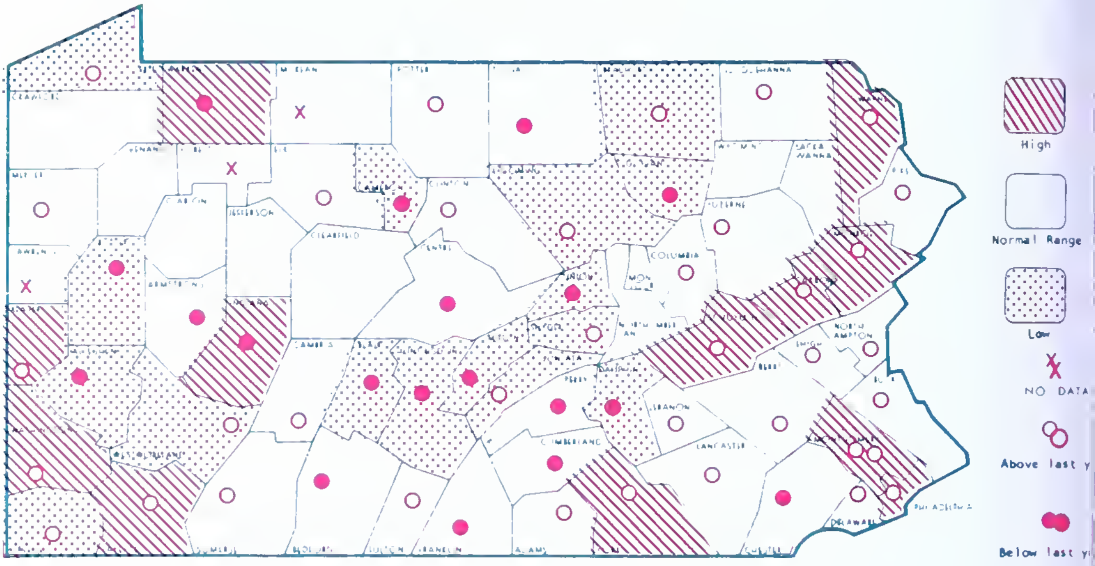

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PENNSYLVANIA GEOLOGY

PENNSYLVANIA GEOLOGICAL SURVEY
150TH ANNIVERSARY
1836 - 1986

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ON THE COVER: Reproduction of copper plate lithograph of Bellefonte, Centre County, sketched by George Lehman, an artist employed by Henry D. Rogers in the 1840's to illustrate *The Geology of Pennsylvania, a Government Survey*, published in Philadelphia, Pa. in 1858.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

VOL. 17, NO. 1 **FEBRUARY 1986**

FROM THE DESK
OF THE
STATE GEOLOGIST

The Pennsylvania Geological Survey Celebrates 150 Years

On March 29, 1836, the Pennsylvania Legislature passed an act which provided for a "Geological and Mineralogical Survey" of the State. Thus, we are celebrating this year the 150th Anniversary of the founding of the Pennsylvania Geological Survey, one of the first state geological surveys in the Nation and one of the oldest agencies in Pennsylvania State Government.

When first authorized, it was contemplated that a geologic survey of the State could be completed and be done with in 10 years. Under the direction of the distinguished Henry Darwin Rogers, after outstanding, perceptive field work and handicapped by lapses in appropriations, a magnificent, two volume, illustrated geologic report of 1631 pages, accompanied by a state geologic map, was issued in 1858. Combining astute scientific observations with romantic prose, that first report provided a comprehensive summary of the geologic framework of Pennsylvania as then understood.

After a hiatus of 16 years, the Second Geological Survey of Pennsylvania was authorized in 1874. J. Peter Lesley served as the Second State Geologist and his staff included such outstanding geologic contributors as C. A. Ashburner, J. F. Carll, E. V. D'Invilliers, F. A. Genth, T. S. Hunt, A. S. McCreath, and I. C. White. By 1887 geologists of the Second Survey had mapped the state in great detail, recording not only the stratigraphy and structure, but placing emphasis upon the burgeoning mineral industry, then the most active in the country. 81 volumes, 35 comprehensive atlases, a grand atlas of county geologic maps, and a new state geologic map (1893) were issued by this distinguished, highly productive staff.

In 1909, after a lapse of some 20 years, the Legislature again authorized a "Topographic and Geologic Survey Commission", with instructions to cooperate with the newly formed U.S. Geological Survey. With Richard R. Hice as the State Geologist, the Third Survey emphasized mineral resource studies in the 17 volumes of geologic reports it issued before its demise in 1914.

Our present Topographic and Geologic Survey, the Fourth Survey, was legislatively mandated in June of 1919. It has been in continuous service since that date, in recognition that the needs for geologic investigations and geologic services are never-ending, and in fact, ever changing. Over the years our Survey has functioned under the Department of Internal Affairs, Department of Forest and Waters, State Planning Board, and since 1971, the Department of Environmental Resources. George H. Ashley served as State Geologist from 1919 to 1946; his geologic insight and achievements, particularly his contributions to coal geology, earned national acclaim. Ashley was succeeded briefly as State Geologist by Ralph Stone; Stanley Cathcart served from 1947 to 1953, Carlyle Gray from 1953 to 1961, and Arthur Socolow from 1961 to the present.

The four Divisions of the Topographic and Geologic Survey (Geologic Mapping, Mineral Resources, Environmental Geology, and Oil and Gas Geology) reflect both the diversity and specialization which are necessary to serve today's varied demands for geologic data and services. The diversity of the Survey's activities is further reflected in over 600 geologic publications and maps which the Fourth Geological Survey has issued over the years. These comprehensive geologic reports are issued under the categories of Atlases, County Reports, General Geology, Environmental Geology, Information Circulars, Mineral Resources, Water Resources, Maps, and State Geologic Map. The latter was completely revised in 1931, 1960, and 1980 to reflect the progress in mapping and new interpretations. A published Educational Series represents the Survey's recognition that geology is also of interest and use to non-technical persons, including students and recreationists. The 46 members of the Survey, including 28 highly trained geologists, are widely recognized for the quality and scope of their contributions. Their detailed geologic work and creative interpretations have served the Pennsylvania Geologic Survey to be recognized amongst the leading Surveys of the Nation.

On the occasion of its 150th Anniversary, the Pennsylvania Geological Survey is proud of its heritage and of its tradition of achievements and services to the Commonwealth and to the geological profession.

Arthur A. Socolow

Franklin County Rock and Mineral Show

The Franklin County Rock and Mineral Club will sponsor their Ninth Annual Show on March 22-23, 1986, at the Chambersburg Middle School, Chambersburg, Pennsylvania. Show hours on the 22nd are 10:00 a.m. - 7:00 p.m.; on the 23rd they are 11:00 a.m. - 5:00 p.m. Lectures and demonstrations will be held during the show, as well as a variety of exhibited displays. For more information, contact Pat Hoyer, 6528 Mountain Dr., Chambersburg, PA 17201, telephone (717) 352-8548.

A Sesquicentennial Story*

EARLY MILLSTONE QUARRY IN TIOGA COUNTY

by Thomas M. Berg

A unique opportunity exists in Tioga County for our readers who are interested in the early development of mining and quarrying activities in Pennsylvania. A very old stone quarry from which millstones were once produced occurs in the upland countryside of Tioga State Forest northwest of Asaph (approximately six miles due west of Wellsboro). To find the site (Figure 1), turn north off U.S. Route 6 at the village of Asaph, and follow the Asaph Run road 3.1 miles toward the northwest to the Asaph Run Picnic Area where the road forks. Follow the right branch of Asaph Road, ascending the valley toward Bear Wallow, for 2.5 miles to another fork in the road. Follow the right branch for about 0.3 mile to "Hesselgessel Road" (a dirt road) which leads into the forest on the right. Follow this back road through the forest for 0.5 mile. The old quarry (Figure 2) is on the right (to the west).

The unique feature which makes a visit here worthwhile is a nearly complete millstone which was left behind after the quarry was abandoned. The millstone is lying in the southern part of the quarry area and is partly covered by the forest undergrowth (Figure 3). The millstone was cut by James Hesselgessel in 1836. Other stones for grist mills produced at this quarry were used at the Beach Mill at Little Marsh, Pa., the Billings Mill at Knoxville, Pa., and the Ainsley Mill at Galeton, Pa. The total number of stones produced here is unknown.

The Hesselgessel millstone was cut from the Olean Conglomerate near the base of the Pottsville Group. This conglomerate is a rock produced from sediment deposited by braided rivers during the Pennsylvanian Period approximately 325 million years ago. The rivers flowed toward the center of the slowly subsiding Appalachian Basin from a northern source area, probably southern Canada (Meckel, 1967). The materials deposited by these ancient rivers across north-central Pennsylvania comprised relatively clean, texturally mature, quartz sand and gravel. These sediments were ultimately buried and cemented together (mostly by secondary silica) to form hard, resis-

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*Celebrating 150 years of The Pennsylvania Geological Survey—1836 to 1986.

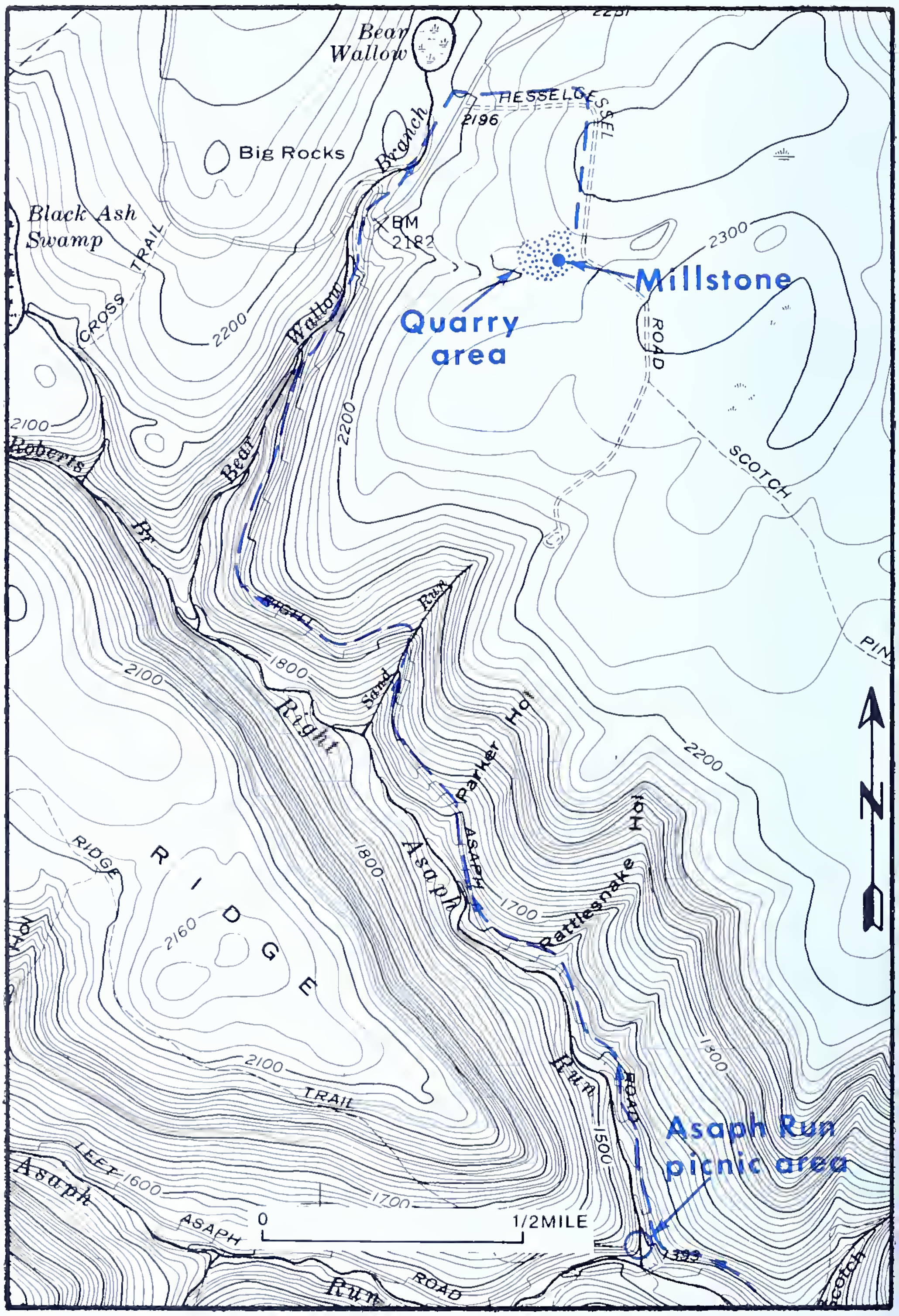


Figure 1. Location of the Hesselgessel millstone quarry in the Asaph Run area of Tioga County.

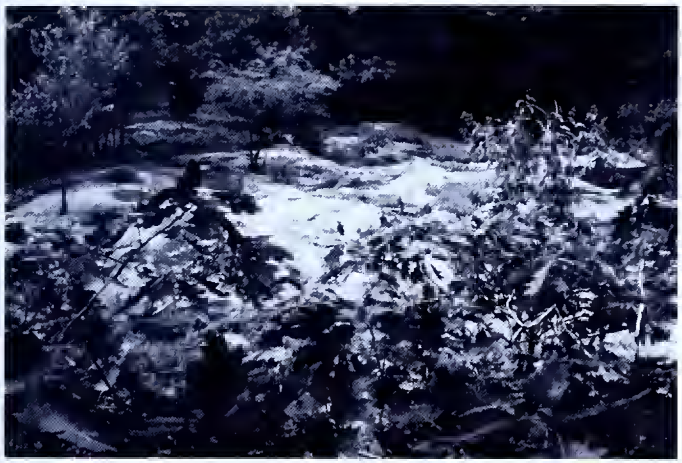
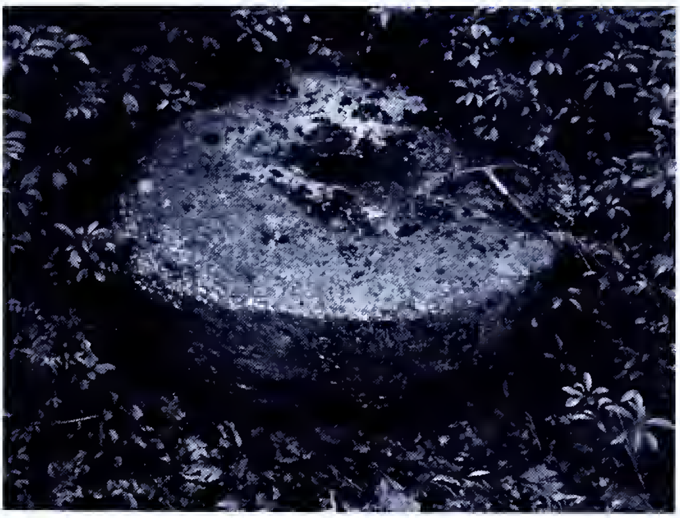


Figure 2. Hesselgessel millstone quarry. Exposures of Olean Conglomerate from which the millstones were cut are partly covered by dense vegetation.

Figure 3. The Hesselgessel millstone. Hammer for scale is about 1 foot long.



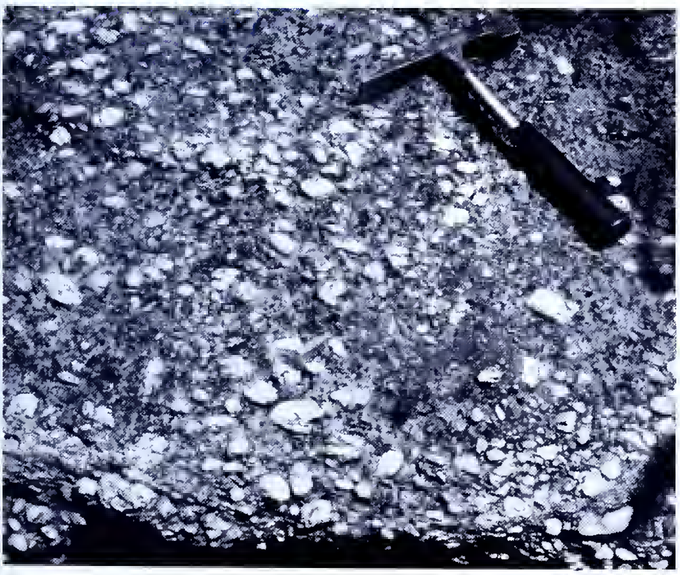


Figure 4. Close-up view of Olean Conglomerate at Hesselgessel quarry. Note size, shape, and abundance of quartz pebbles. Hammer gives scale.

tant layers of conglomerate (Figure 4) and quartzose sandstone. Erosion of these resistant rock layers has produced prominent low cliffs, benches, and "rock cities" that are quite distinctive on aerial photographs.

When the Hesselgessel millstone was cut in 1836, the Pennsylvania Geological Survey was in its first year. The names applied to these massive conglomerates and sandstones by geologists in those early days included "Formation XII," the "Seral conglomerate," and the "Millstone Grit." The latter name originated in England where rocks of the same approximate geologic age were also used for millstones] The present-day name "Olean" derives from similar prominent outcrops at "Rock City" south of Olean, New York. The "Pottsville Group" takes its name from the vicinity of Pottsville, Pa., where rocks of the same age and relative stratigraphic position are exposed.

There are other points of interest in the millstone area. About one mile west of the quarry is Black Ash Swamp State Forest Natural Area (Figure 1). Black Ash Swamp is a mountain bog wetland created in part by beavers. Visitors will see typical northern hardwood forest species including birch, beech, maple, cherry, and white ash. No black ash have been observed. An active beaver colony may be seen at Bear Wallow (Figure 1). Other wildlife include deer, bear, turkeys, and some rattlesnakes. Be cautious of rattlesnakes in the quarry area.

Enjoy your visit to this historic and beautiful part of Tioga County, and remember to leave it as you found it!

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CAVES OF LEHIGH COUNTY, PENNSYLVANI

Caves of Lehigh County is the newest addition to the MAR Bulletins from the Mid-Appalachian Region of the National Speleological Society. Twenty-five known caves in Lehigh County are listed. A description is included for each cave and, where possible, a map. Of the 25 known caves, 17 are closed or otherwise inaccessible. Seven of the accessible caves are on private land and permission must be obtained before entering.

Similar information is also available for Huntingdon, Snyder, Centre, Mifflin, Perry, Bucks and Lehigh Counties.

These publications are available from Bette White, 542 Glenn Road, State College, PA 16803.

MID-APPALACHIAN REGION BULLETINS AVAILABLE

#9	Caves of Huntingdon Co., Pa.	40 caves	$2.75 + postage*
#10	Caves of Snyder Co., Pa.	20 caves	1.25 + postage*
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The West Liberty Esker

by Gary M. Fleeger
Denver, Colorado

The West Liberty Esker (Figure 1) was deposited during the Kent deglaciation about 23,000 years ago. It occurs in three segments over a distance of 6½ miles between Harlansburg, Lawrence County, and West Liberty, Butler County, separated by post-glacial erosion by Slippery Rock Creek and Taylor Run. The northwestern, upstream segment consists of several short eskers that appear to form a tributary pattern with the main esker. The southeastern segment ends at a kame delta that was deposited in a proglacial lake. The esker is com-

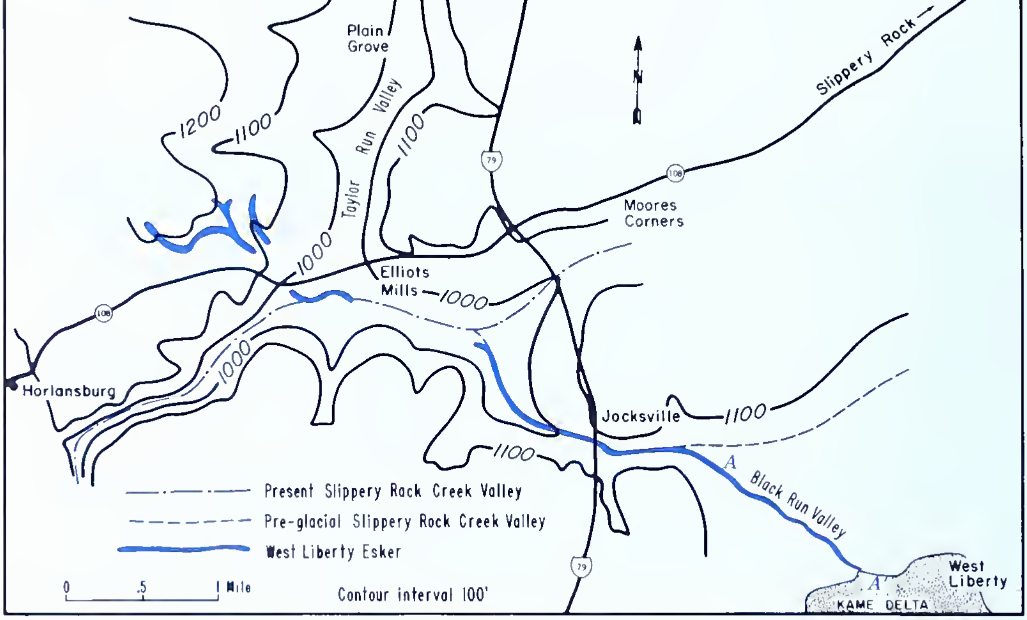

Figure 1. Bedrock contour map (from Poth, 1963) showing location of West Liberty Esker.

posed of cobbles, gravel, and sand, with grain size generally increasing downstream. Till caps the esker sediment in some places, while glaciofluvial gravels are present to the top in other sections. Delliquadri (1951) reported pebble lithologies of predominantly granite, gneiss, sandstone, and quartzite.

Eskers were once assumed to have been deposited only by streams flowing through subglacial meltwater tunnels. However, they can also be deposited in englacial tunnels, open supraglacial channels, or at the glacier front where a meltwater channel or tunnel emerges. A close look at the structure and morphology indicates that the West Liberty Esker was deposited at both subglacial and ice frontal positions.

Evidence that the esker was deposited in a tunnel is the downstream increase in elevation of the base of the esker, from 1100 feet at Slippery Rock Creek to 1215 feet at the kame delta. Water can flow uphill only when a sufficient hydrostatic head is developed in a full flowing tunnel because of the greater thickness of the overlying ice upstream than downstream. An esker extending uphill can also result from the lowering of an englacial tunnel esker or a supraglacial channel esker during melting of the supporting ice, or a time transgressive esker deposited at the ice front as the glacier retreated downhill (Banarjee and McDonald, 1975). There is no deformation of the entire esker to indicate melting of supporting ice. Extensive faulting only along the edges (Geyer and Bolles, 1979), because of slope failure during the melting of the ice walls, indicates that the West Liberty Esker was deposited in a subglacial tunnel, and not at an englacial, supraglacial, or ice front position. Some ice front deposition did occur, but is not the main location of deposition.

Another indication that the esker was deposited in a subglacial tunnel is that most of it follows the buried, preglacial valleys of Slippery Rock Creek and Black Run (Figure 1). This can happen only if the tunnel is at the base of the glacier, in contact with the land surface (Banarjee and McDonald, 1975).

The morphology of the West Liberty Esker also gives an indication of the character of the Kent glacier. The esker is sinuous in the upstream part, but changes southeast of Jacksville, where it has angular bends and parallel straight segments. This is due to differences in ice thickness. At depths greater than 100 feet in a glacier, the overlying weight causes the ice to behave plastically (Sugden and John, 1976) so that crevasses will not extend into the glacier more than about 100 feet. Subglacial tunnels follow fractures in the ice where they reach the base of the glacier (Stenborg, 1968), suggesting that the Kent glacier was 100 feet thick or less near its terminus when the straight esker segments were deposited. A very thin glacier is consistent with the thin, discontinuous Kent Till in northeastern Ohio and northwestern Pennsylvania.

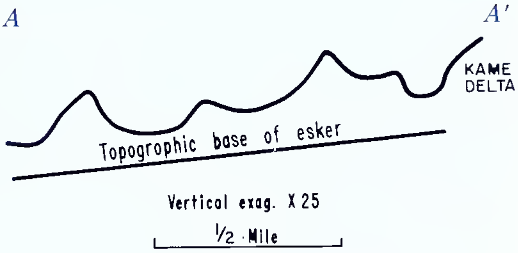

Figure 2. Profile along downstream portion of West Liberty Esker between locations A and A^1 shown on Figure 1.

The esker southeast of Jacksville has higher mounds, or beads, at 1700 foot intervals (Figure 2). Increased summer meltwater discharge may have deposited greater amounts of sediment on top of the subglacial tunnel esker at the tunnel mouth as the ice front melted back. This would indicate that the initial rate of annual retreat of the Kent glacier was 1700 feet.

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Building Stones From Cumberland County

Caretti, Inc., a Cumberland County masonry contractor, controls the last known active limestone quarry used solely as a source of building stone in Pennsylvania. It has long provided quarry-run and ashlar blocks for buildings such as at Dickinson College and Pennsylvania Turnpike Service Areas. The Carlisle area is underlain by carbonates that were early recognized by pioneers as valuable assets. In 1753, John O'Neal, Esq., wrote to Governor Hamilton, "A lime kiln stands on the centre square, near what is called the deep quarry, from which is obtained good building stone." (Rupp, 1846, p. 389). It was then considered favorable and a status symbol to have a quarry in the center of town. Furthermore, according to the 1840 county census, of the 67 houses built, 49% were of brick and stone (Rupp, 1846).

The Caretti Quarry is located in West Pennsboro Township about 0.8 miles NW of Plainfield, Pennsylvania, near the south bank of the Conodoguinet Creek. Here, since after the turn of the century, three generations of Morrisons have worked this quarry by hand (Figure 1). Paul W. Morrison lives nearby and is the retired quarry foreman. Dante Caretti and his son, Sam, bought this quarry as a captive source of local building stone around 1966.

The Chambersburg Formation, as exposed in the quarry (Berg and others, 1980), is characterized as a dark gray, flaggy-to-slabby bedded, carbonate mudstone (micrite) having a conchoidal-like fracture and generally containing minor amounts of fossil fragments of gastropods, brachiopods, bryozoans, crinoids (?), and corals, (?). Some of the fossil fragments are replaced by coarsely crystalline calcite and to a lessor degree, by pyrite. Some carbonaceous material is locally present along stylolites and calcite replacements. Up to one-inch-thick, black, slightly undulatory, argillaceous bands occur between the generally 4-10 inch thick limestone beds. Prominant, near-vertical joints are filled with both clay and calcite. These joints are used as temporary backs or quarry faces in the working benches. The median attitude of the beds is about N13°E, 20°SE while the median joint attitude is quite variable but trends N55°W, 70°SW. Prominant slickensides on some calcite-filled bedding surfaces (flexure slip) trend N16°W. The

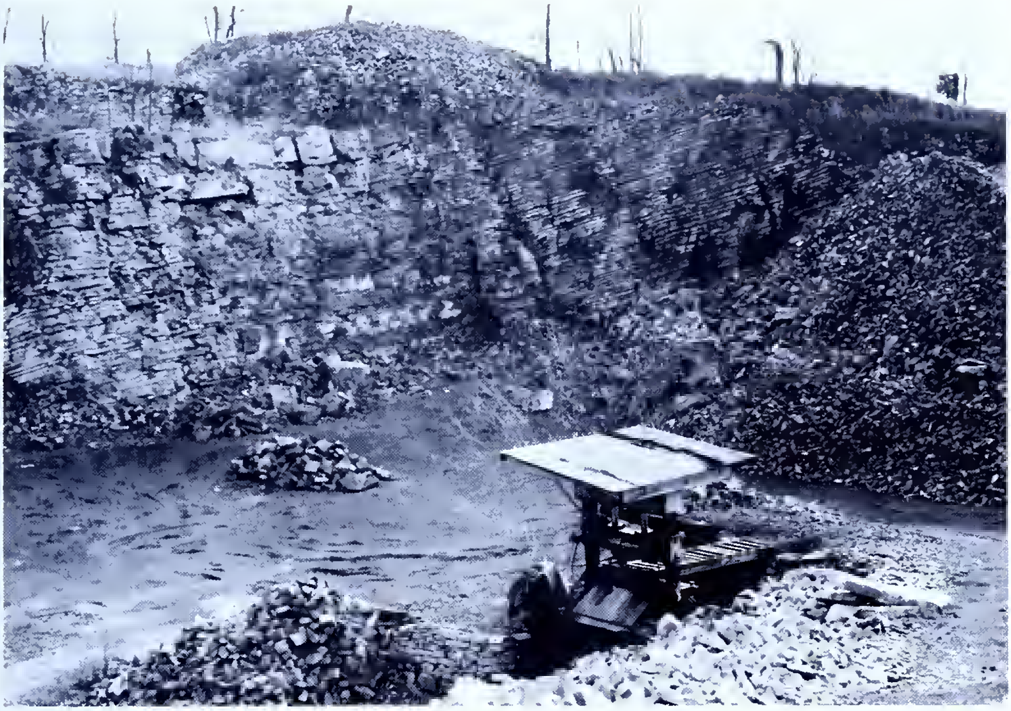

Figure 1. View of the active Caretti Quarry looking to the southeast. Note the flaggy to slabby bedding. Quarry waste is being backfilled to the west (right). Hydraulic rock cutter is in the foreground. Stockpile on floor of quarry is about 9 tons of random-size quarry-run.

quarry face trends N30°E. Reserves remain on the east side of the quarry while quarry waste is backfilled to the west.

Quarrying is done mostly by hand. Initial benches are started by jackhammer drilling 1.5-inch-diameter holes about 4 feet deep on centers ranging between 2.5 feet and 4 feet parallel to the quarry face. Coarse-grained black-powder charges (typically, 10-to-20 ozs. in the bottom of the hole) are used as a blasting agent to reduce discordant fracturing and free workable blocks along bedding within benches. Conventional drilling and blasting has been unsuccessfully tried. Pry bars and muscle are standard working tools. The ring of a hammer against a sound rock, and a trained ear, constitute quality control.

Two basic types of stone are marketed; random-size quarry-run, which usually has one square corner, and random-size ashlar having eight square corners (Figure 2). Ashlar blocks up to 3 feet by 15 inches by 8 inches thick are cut by a hydraulic guillontine which reduces hand labor. Intricate keystones and other patterns can be

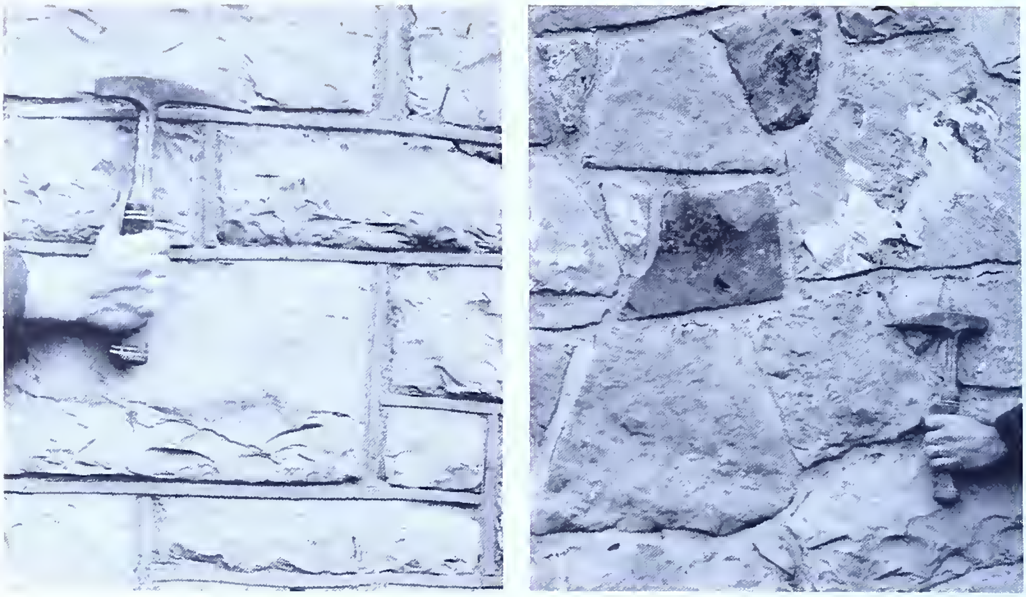

Figure 2. Composite photo of basic types of stone produced. Left is ashlar with a "riser" below hammer handle. Right is random-size quarry-run showing "shiners" (dark blocks near top-center) and a calcite-rich bedding plane having slickensides (above hammer).

cut on this machine, which exerts between 2500 and 3000 psi of force. The characteristic light gray color of the dressed stone is developed through weathering (intrinsically the stone is dark gray) or, for the less patient, by sandblasting. For visual contrast in walls, "risers" (blocks generally one foot or more in diameter), "shiners" (bedding-plane surfaces reflecting light from carbonaceous bands), and the slickensided calcite-rich bedding planes can be used.

The quarry annually produces between 200 and 700 tons of quality dimension stone for regional markets. In addition to being a source of building stone for Dickinson College and the Turnpike service area, this quarry has provided stone for Carlisle Hospital, Shaffer Medical Center in Lemoyne, and several private residences.

We thank Mr. Gregory R. Hess, President, and Paul W. Morrison, quarry foreman, Carretti Inc., for their help in preparing this article.

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Diverse Fauna at Beaver County Fossil Locality

by John A. Harper

The Ames Limestone and associated shales have been recognized for many years as remarkably fossiliferous rocks in a relatively barren stratigraphic succession. The highest unit of the Glenshaw Formation, Conemaugh Group, the Ames is the most persistent and widespread Pennsylvanian-aged stratum in western Pennsylvania. The abundance of crinoid debris, especially columnals, makes the Ames easily recognizable and, in fact, gave the Ames its first name, the "crinoidal lime." Fossils are abundant in the Ames throughout western Pennsylvania and Maryland, eastern Ohio, and northern West Virginia, but as Raymond (1910) pointed out, "...it is only under favorable conditions that any variety of species can be obtained." Raymond listed 44 species of fossil vertebrates and invertebrates from the Ames at the Brilliant railroad cut in Pittsburgh, but such diversity is uncommon. More common are examples like the Ames at Beatty, Pennsylvania with only 5 species recognized by Raymond.

A newly examined Ames locality in Beaver County comes close to the Brilliant cut locality in faunal diversity and abundance, and with further collecting may prove to contain even more species than those reported here. Fully 31 species of invertebrates, vertebrates and trace fossils, and numerous unidentifiable fragments of brachiopods, molluscs, crinoids and vertebrate material, were collected and identified during two short visits to the locality. Among these are several species rarely or never before cited from the Ames of Pennsylvania.

The locality is in Beaver County, on the east side of the northbound lane of PA 60, the Beaver Valley Expressway, 0.3 miles south of the exit ramp to Aliquippa, and 0.7 miles south of Green Garden Road (Figure 1). The Ames crops out about 30 feet above the highway, but the best collecting comes from large slabs and blocks of limestone within a shale-chip and claystone talus slope formed by the underlying Pittsburgh "red beds" and overlying Birmingham Shale. The collecting locality consists of two sites approximately 100 yards apart, separated by a zone of sparse blocks. Site A, the southernmost, is a set of three large slabs of Ames lying on talus about 10 to 20 feet above the highway (Figure 2). The lowest slab is

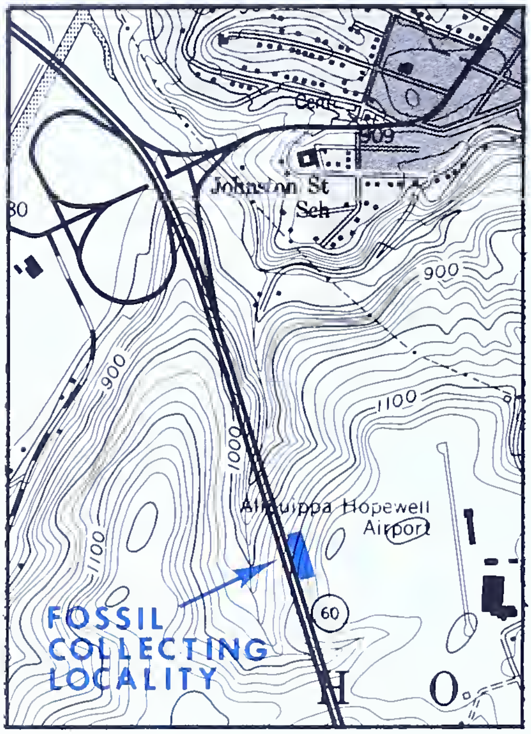

Figure 1. Location of the Beaver County fossil collecting site along Pa. Route 60, the Beaver Valley Expressway at Aliquippa.

also the largest and contains what appears to be the single most diverse fauna seen in the Ames. Smaller blocks of limestone also occur lower on the slope. Site B consists of small to medium-sized blocks containing a more "normal" Ames fauna (see Table 1). Both sites contain some interesting faunal elements, and three of these are discussed here.

1. *Enteletes hemiplicatus* (Hall), an orthid brachiopod, has been documented in the Ames of Ohio (Sturgeon and Hoare, 1968), but has not been recorded from anywhere else in the Appalachian Basin; it is more commonly found in the Pennsylvania rocks of the midcontinent area. At Site A, *Enteletes* is actually more common than some other brachiopods, particularly forms such as *Crurithyris planoconvexa* (Shumard) and *Wellerella osagensis* (Swallow) which is considered typical of the Ames in western Pennsylvania.

2. Identifiable platyceratid gastropods are extremely rare in the Conemaugh Group, even in the Ames with its abundant crinoid fauna (platyceratids are known to have lived attached to the anal openings of crinozoan echinoderms). Raymond (1910) reported two species in the Allegheny and Conemaugh Groups, but only one of these was cited from the Ames. Four well-preserved specimens of *Strophostylus girtyi* (Knight), a platyceratid, were collected from Site A. Most of the molluscs at this locality consist primarily of phosphatic molds and casts because of dissolution of their aragonitic shells. Those fossils which originally had calcitic shells, the brachiopods, corals and echinoderms, retain their shell structure and their character. This is also the case for the platyceratids, a gastropod group which had original calcitic shells.

Table 1. Faunal list from new Beaver County fossil collecting locality. Two sites, not actually separated, with Site A being the best collecting, Site B about 0.05 miles north of Site A.

SPECIES	LOCALITY SITE A	 SITE B
Corals		
Stereostylus sturgeoni Bebout	X	X
Brachiopods		
Enteletes hemiplicatus (Hall)	X	
Derbyia crassa (Meek & Hayden)	X	X
Derbyia parvicostata Sturgeon & Hoare	X	X
Orthotetes conemaughensis Sturgeon & Hoare	X	
Neochonetes granulifer (Owens)	X	X
Hystriculina wabashensis (Norwood & Pratten)	X	X
Antiquatonia portlockiana (Norwood & Pratten)	X	
Reticulatia huecoensis (King)	X	
Juresania nebrascensis (Owen)	X	X
Linoproductus prattenianus (Norwood & Pratten)	X	X
Linoproductus platyumbonus Dunbar & Condra	X	
Wellerella osagensis (Swallow)	X	X
Hustedia mormoni (Marcou)		X
Composita subtilita (Hall)	X	X
Composita ovata Mather	X	X
Composita elongata Dunbar & Condra		X
Cleiothyridina orbicularis (McChesney)	X	
Neospirifer dunbari King	X	X
Crurithyris planoconvexa (Shumard)	X	X
Phricodothyris perplexa (McChesney)	X	
Bivalves		
Septimyalina? sp.	X	
Wilkingia terminale (Hall)	X	

SPECIES	LOCALITY SITE A	 SITE B
Gastropods		
Knightites (Cymatospira) montfortianus (Norwood & Pratten)	X	
Strophostylus girtyi (Knight)	X	
Strobeus sp. cf. *S. primogenius* (Conrad)	X	
Cephalopods		
Brachycycloceras curtum (Meek & Worthen)	X	
Pseudorthoceras knoxense (McChesney)	X	
Tainoceras collinsi Sturgeon, Windle, Mapes & Hoare	X	
Schistoceras hildrethi (Morton)	X	
Crinoids		
Delocrinus sp.		X
Fish		
Petalodus ohioensis Safford	X	
Trace Fossils		
Tremichnus cysticus Brett		X
Miscellaneous		
Miscellaneous brachiopod spines		X
Unidentifiable cephalopod fragments	X	
Miscellaneous columnals, plates & spines	X	X
Unidentifiable vertebrate debris	X	

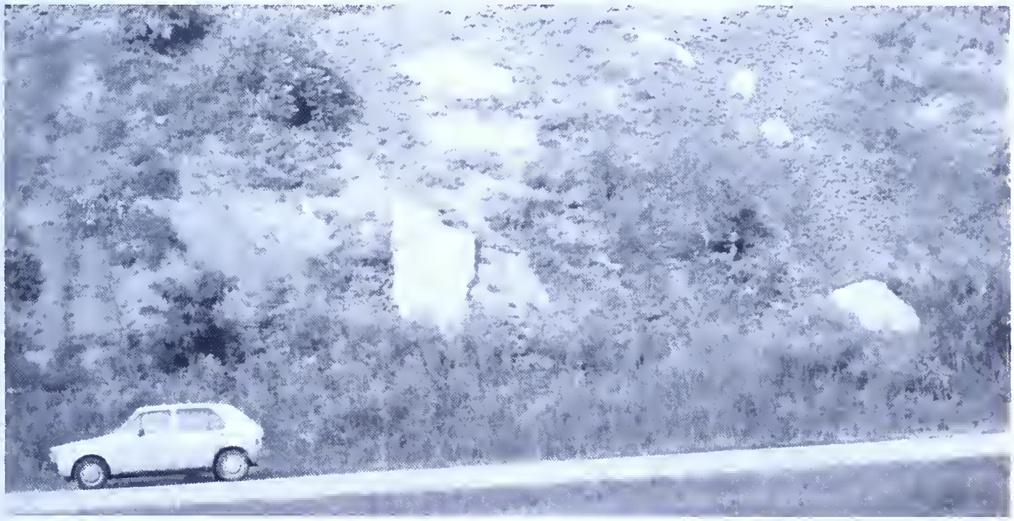

Figure 2. Outcrop of the Ames Limestone (toward the top of the photo) along the northbound lanes of the Beaver Valley Expressway (Site A). Large slabs of Ames have broken away and are resting on shale-chip talus. The largest slab (center) has the most diverse fauna.

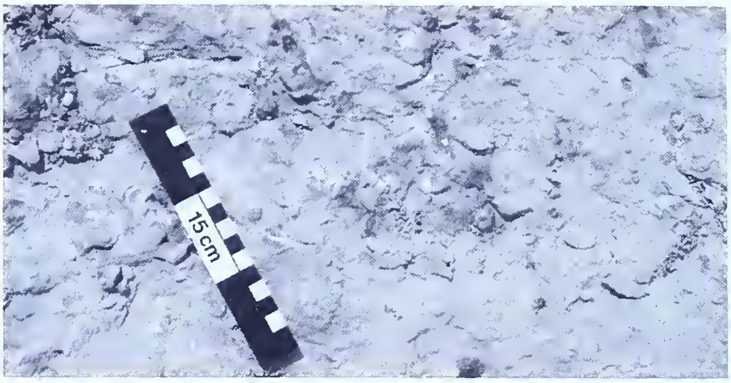

Figure 3. Surface of the Ames Limestone at Site A showing large amount of fossil debris, particularly crinoid columnals and brachiopods.

3. As Brett (1985) has pointed out, a variety of previously unnamed trace fossils are found associated with fossil echinoderms, particularly crinoids. The name *Tremichnus* was coined by Brett for one type, expressed as circular or parabolic pits, often occurring in gall-like swellings, in crinoid plates. These pits are common in Middle Ordovician through Permian crinoid fossils, but in the North American Pennsylvanian such pits have only been described previously from the midcontinent area. Recognition of the ichnofossil *Tremichnus cysticus* Brett in crinoid stems from the Ames Limestone at the Beaver Valley Expressway locality positively extends the geographic range of Late Paleozoic *Tremichnus* into the Appalachian Basin.

Those interested in visiting this new fossil-collecting locality should be aware that PA 60 is a high-speed, four-lane, divided highway similar to an interstate highway. Because the collecting is restricted to the east side of the northbound lanes, there should be no reason to cross the highway. If you are approaching the locality from the north, you should go to the next interchange (PA 151) about 2 miles south where you can turn around and enter the northbound lane. Caution should be exercised in parking and walking on the road. Parking is available on the wide shoulders, and cars should be pulled as far off the side of the road as possible.

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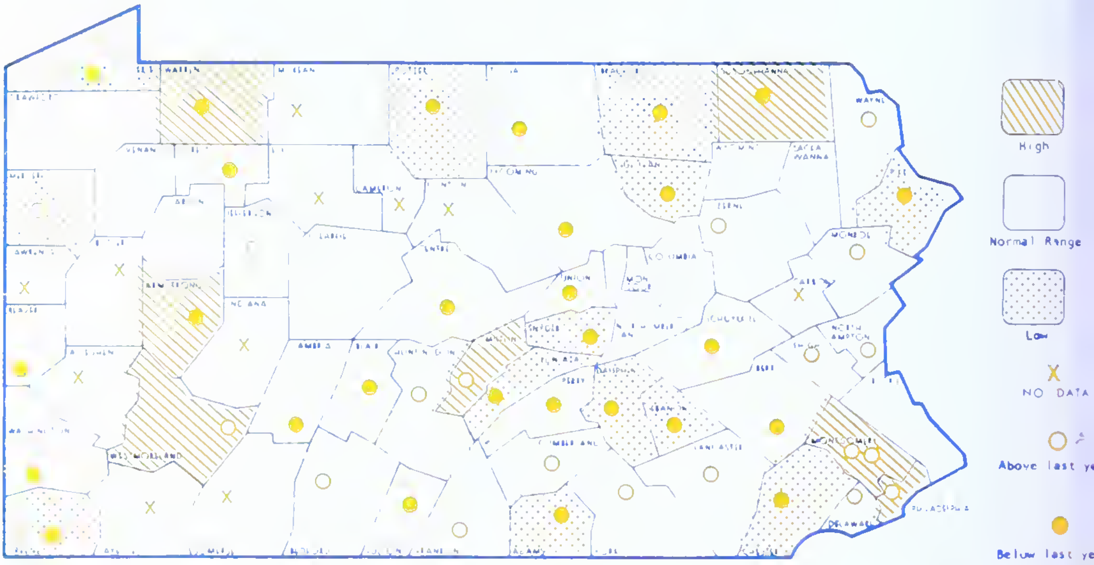

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ON THE COVER: Reproduction of copper plate lithograph of sandstones exposed along the Juniata Canal at Stone Ridge, Huntingdon County, sketched by George Lehman, an artist employed by Henry D. Rogers in the 1840's to illustrate *The Geology of Pennsylvania, a Government Survey,* published in Philadelphia, Pa. in 1858.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

VOL. 17, No. 2 **APRIL 1986**

FROM THE DESK
OF THE
STATE GEOLOGIST

OUR SURVEY, PAST AND PRESENT

As we proceed through 1986, our sesquicentennial Anniversary, it is appropriate to reflect on the accomplishments and the changes which have taken place in the Pennsylvania Geological Survey over the past 150 years.

It is especially appropriate that we recognize the tremendous geologic achievements of the First and Second Pennsylvania Geological Surveys which spanned the era from 1836 to 1895. Moving about by horse and on foot, and without the benefit of the topographic maps and air photo coverage we take for granted today, the Survey geologists of the last century mapped and reported with skill and detail essentially every sector of the Commonwealth. Under Henry Darwin Rogers and J. Peter Lesley, the geologic staff identified the stratigraphic sequence and complex structural framework which characterizes Pennsylvania's geology. Careful attention was paid as well to recording the economic aspects of geology, the array of mineral resources which by the 1880's were being tapped by hundreds of metallic and non-metallic mines across the state.

The Third Pennsylvania Survey in its brief history between 1899-1919, focused heavily upon the needs of the active mineral industry in the Commonwealth, cooperated in the preparation of quadrangle topographic maps, and also made some additional contributions to the geologic framework of Pennsylvania.

The Pennsylvania Geological Survey today, re-established in 1919 as the Fourth Survey, has moved forward on the foundation provided by our predecessors of the last century. Working in great detail on an area-by-area basis, and with the aid of modern lab techniques, the stratigraphy has been greatly refined and subdivided. Detailed air photos, topographic maps, and re-examination of field data in the light of contemporary structural concepts have enabled our Fourth Survey geologists to redefine the structural framework and genetic history of the multiple deformations of Pennsylvania's rock formations. Sophisticated, modern equipment in the field and lab have enabled our economic geologists to define the nature of our known mineral resources and to locate new resources needed for our ever-consuming mineral industry.

Our Survey continues to function in recognition that the science of geology, like all sciences, is ever-progressing, with increasing ability to serve the needs of Pennsylvania, needs which themselves are ever-changing.

Arthur A. Socolow

A Sesquicentennial Story*

MOUNT ETNA IRON FURNACE PLANTATION, BLAIR COUNTY

by Jon D. Inners
Pennsylvania Geological Survey

In 1836, the inaugural year of the First Pennsylvania Geological Survey, J. F. Frazer conducted a traverse along Yellow Creek, Bedford County, from the Broad Top Coal Basin to the south end of Morrison's Cove. Not only did this investigation establish the bedrock succession of central Pennsylvania (Hoskins, 1986), but it also confirmed the general stratigraphic position of one of the Commonwealth's great historic mineral resources—the "brown hematite" (iron) ores of "Formation No. II" (the Cambro-Ordovician carbonates of modern usage). At the time of Frazer's geologic studies on Yellow Creek, the charcoal iron industry was entering the era of its greatest prosperity. Growing population and a better transportation network led to expanded markets, and the introduction of "hot-blast" technology greatly increased the efficiency of the iron furnaces. Approximately 25 miles north of Yellow Creek, a remarkably complete but unrestored example of one of the many "iron plantations" that flourished in the Morrison's Cove area during the 1830's is preserved at Mount Etna in Canoe Valley (Figure 1).

The Mount Etna ironworks was the first within what is now Blair County. In 1807, John Canan, David Stewart, and William (?)Moore commenced building an iron furnace and forge on land bordering Roaring Run and the Frankstown Branch of the Juniata River in Catharine Township. The furnace (Figure 2) was "blown-in" in 1809 and continued to operate intermittently for the next 68 years, despite frequent changes of ownership. (The furnace and plantation were named for the figurative resemblance of the fire-belching furnace to a volcano, specifically Mount Etna on the Mediterranean island of Sicily). Mount Etna plantation experienced its halcyon days between 1830 and 1865, first under the proprietorship of Henry S. Spang and then of Samuel Isett. Many of the auxiliary structures still standing—including the mansion house, workers' apartments (Figure 3), office-store, and manager's house—were built by Spang in the 1830's and 1840's (Sweetnam and Smith, 1976). In this period at least 130 men were employed as founders, casters, miners, colliers, woodcutters, farmers, blacksmiths, and laborers on the plantation (Blair County Historical Society, 1961). Considering that many of these workers

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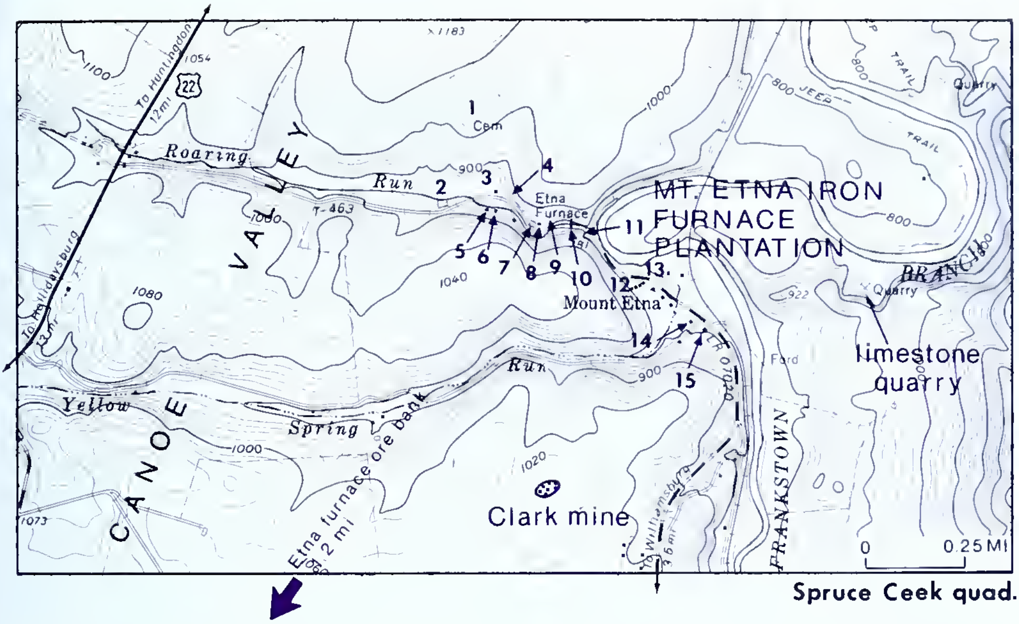
*Celebrating 150 years of The Pennsylvania Geological Survey—1836 to 1986.



Spruce Ceek quad.

Figure 1. Map of Mount Etna iron furnace plantation, showing location of important buildings, ruins, quarries, ore pits, etc. Key: 1 = childrens' cemetery; 2 = stone barn; 3 = workers' apartments; 4 = blacksmith's shop (ruins); 5 = office-store; 6 = manager's house; 7 = furnace stack; 8 = tender's shack (remodeled); 9 = charcoal house (ruins); 10 = mill dam; 11 = site of grist mill; 12 = site of school; 13 = workers' cabins; 14 = approximate site of forge; 15 = mansion; 16 = church.

had families who lived on the premises, the population of Mount Etna must have been several hundred people. Under Isett, the ironworks apparently prospered during the Civil War, but the enterprise foundered soon afterward. Faced with insurmountable financial difficulties brought on by stiff competition from the rapidly expanding iron and steel industry in Pittsburgh, Isett allowed the furnace to go out of blast in 1877.

The four requisites for the manufacture of iron—iron ore, limestone, fuel, and power—were all in plentiful supply at Mount Etna. Iron ore was obtained from several pits (not all of which are indicated on Figure 1) within three miles of the works. Most of this ore was a mixture of limonite ($FeO{\cdot}OH{\cdot}nH_2O$) and goethite ($FeO{\cdot}OH$) ("brown hematite") that occurred in stalactitic, mammillary, and botryoidal masses in variegated clays weathered from the limestones and dolomites of "Formation No. II." By far the greatest amounts of ore came from "banks" in the Upper Cambrian Gatesburg Formation on the "Barrens" north of Williamsburg. Limestone, needed to flux the impurities in the ore, was secured from a large quarry in the upper part of "Formation No. II" (mainly Middle to Upper Ordovician

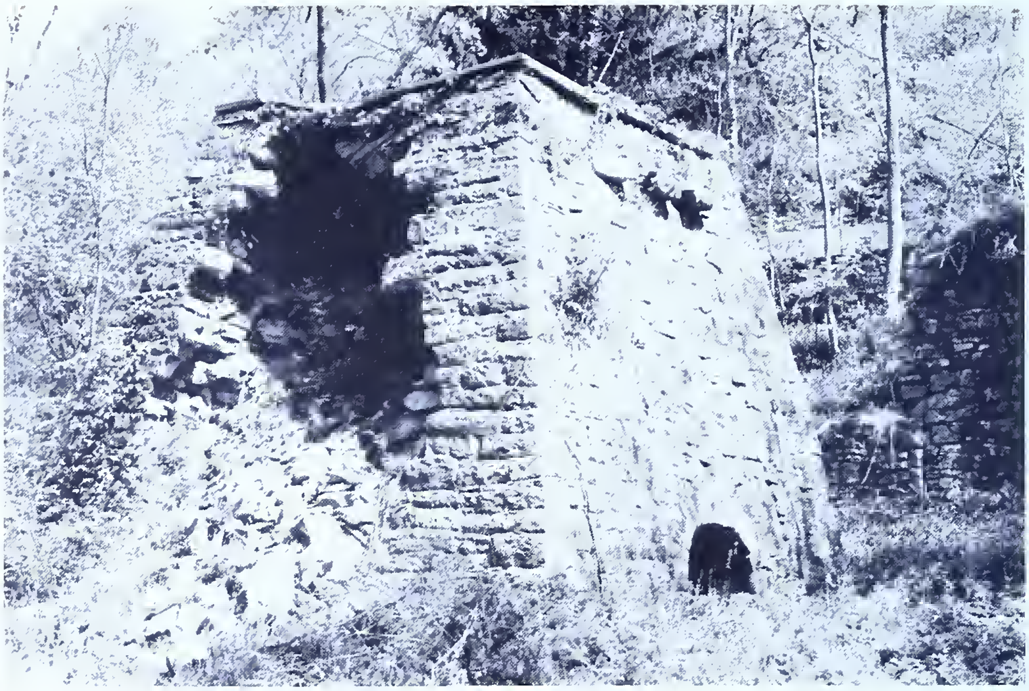


Figure 2. Etna furnace stack as it appeared in the spring of 1985. The large work arch, which opened into the casting shed, collapsed in 1975. At the right is the tuyere arch. A high stone wall forms the edge of the charging terrace. Like most remaining structures at Mount Etna, the furnace and terrace walls are constructed of dolomite from the Lower Ordovician Nittany Formation.

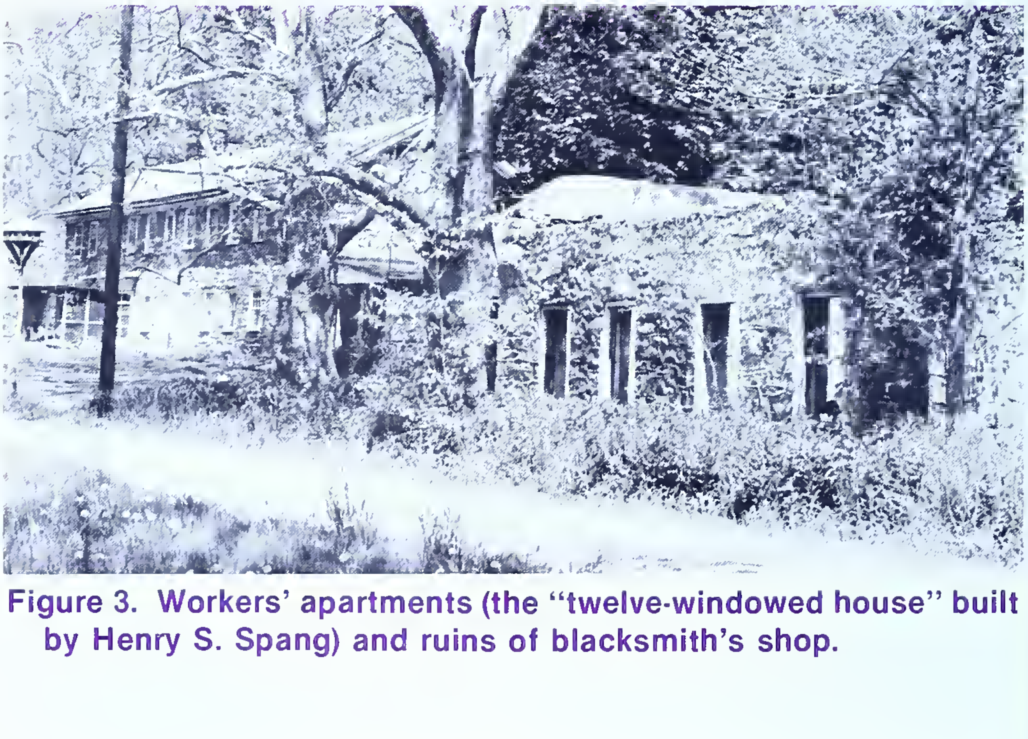


Figure 3. Workers' apartments (the "twelve-windowed house" built by Henry S. Spang) and ruins of blacksmith's shop.

carbonates of the Bellefonte, Loysburg, and Hatter Formations) 0.9 mile east of the furnace. The hardwood forests that clothed the hills surrounding the iron works supplied the vast quantities of charcoal fuel necessary to feed the insatiable fires of the blast furnace. Power to run the blast machinery was provided by a large water wheel (Figure 4) situated to take advantage of an abrupt increase in stream gradient (to 200 feet per mile) about 0.25 mile above the mouth of Roaring Run.

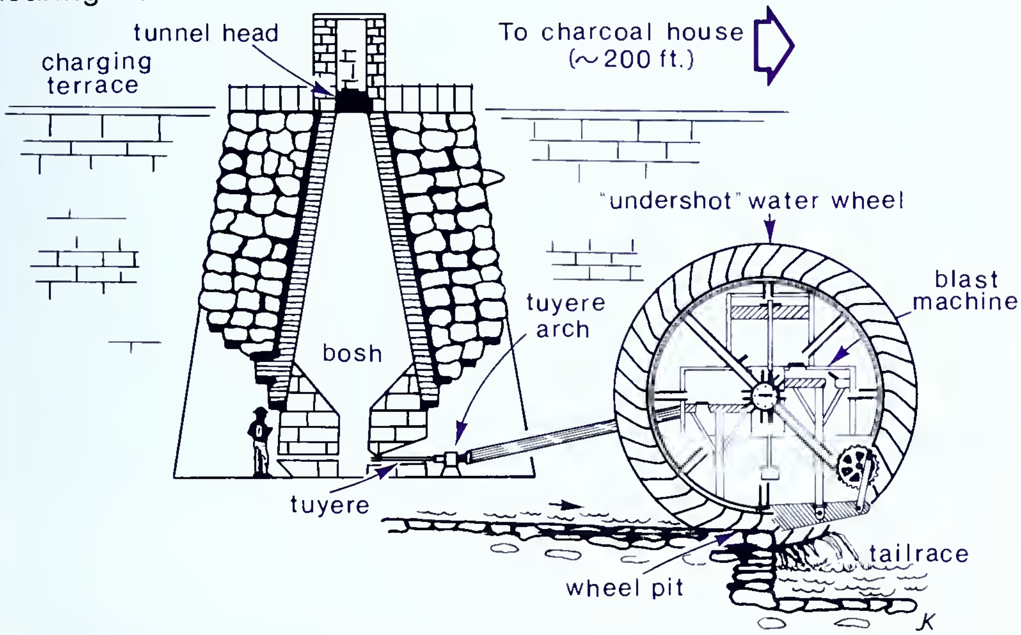


Figure 4. Generalized (and very hypothetical) drawing of Etna furnace as it may have appeared in its early "cold-blast charcoal" period. The furnace was probably converted to "hot-blast" by Spang in the 1840's. Lesley (1859) reported that Etna furnace was 31 feet high and had an 8-foot bosh.

According to Platt (1881), Etna furnace made an excellent cast iron, relatively low in both phosphorus (less than 0.30 percent) and sulfur (less than 0.01 percent). During the decades of its greatest productivity (1830 to 1870), the furnace was capable of producing more than 1000 tons of pig (cast) iron annually (Lesley, 1859). Most of this was used at the forge to manufacture approximately 600 tons of wrought iron in peak years (Blair County Historical Society, 1961).

Mount Etna iron furnace plantation is most easily reached from U.S. Route 22 (see Figure 1). Turn east onto Township Route 463 at the historical marker 1.4 miles southwest of the Blair-Huntingdon County line and proceed 0.9 mile to the first cluster of stone buildings, including the stone barn, workers' apartments, and furnace stack. Approximately 0.3 mile farther east, turn south on L.R. 07020 and continue another 0.2 mile to the second grouping of buildings containing the workers' cabins, mansion, and church. Please bear in mind that all land encompassing the old plantation is *PRIVATE PROPERTY*. Permission to explore the grounds north of Roaring Run can be obtained from the current inhabitants at the "twelve-windowed house." The furnace stack itself is owned by the Blair County Historical Society. Trespassing on the land south of Roaring Run and on the properties near the Juniata River is not permitted.

The author thanks William I. Richardson, Williamsburg R.D. #1, for his invaluable assistance in preparing this article.

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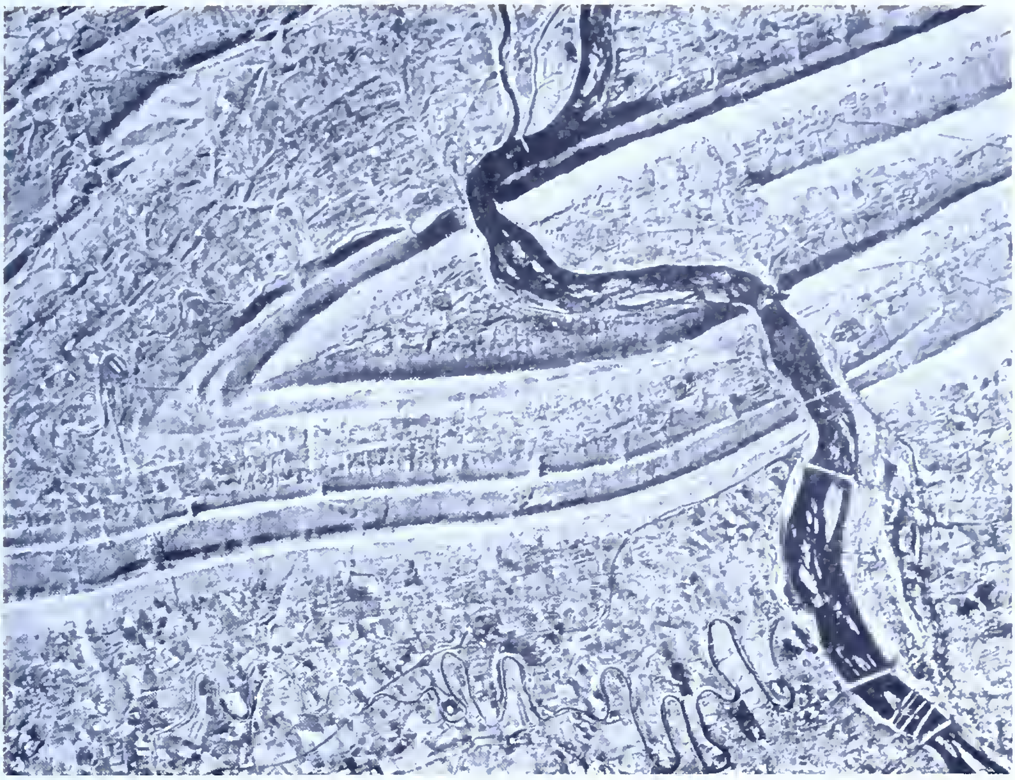
RADAR IMAGE MOSAIC OF CENTRAL PENNSYLVANIA SHOWS FOLDED APPALACHIANS

The folds of the Appalachian Mountains in a portion of central Pennsylvania are vividly depicted in a side-looking airborne radar (SLAR) image mosaic published by the U.S. Geological Survey.

The 1:250,000-scale (one inch represents about four miles) mosaic of the Harrisburg quadrangle is one of several experimental SLAR-image products recently produced as examples of the data acquired under the U.S. Geological Survey's SLAR program. SLAR data of about 527,000 square miles within the counterminous United States and Alaska are now available for purchase.

The mosaic clearly depicts the parallel ridges and valleys characteristic of the extensively folded Appalachian Mountains in Pennsylvania. The Susquehanna River and its many tributaries clearly show up on the SLAR mosaic.



South-central portion of the Harrisburg, PA, Radar Image Map, showing northeast-southwest trending parallel mountains and valleys characteristic of the folded Appalachians in Pennsylvania. The Susquehanna River bisects the image, and is joined on its west bank by the Juniata River near the top of the image. Harrisburg is on the east bank of the river south of the mountains.

The mosaic depicts all of Dauphin, Juniata, Lebanon, Mifflin, Perry and Snyder counties, as well as parts of Adams, Berks, Centre, Clinton, Columbia, Cumberland, Franklin, Fulton, Huntingdon, Lancaster, Luzerne, Montour, Northumberland, Schuylkill, Union and York counties.

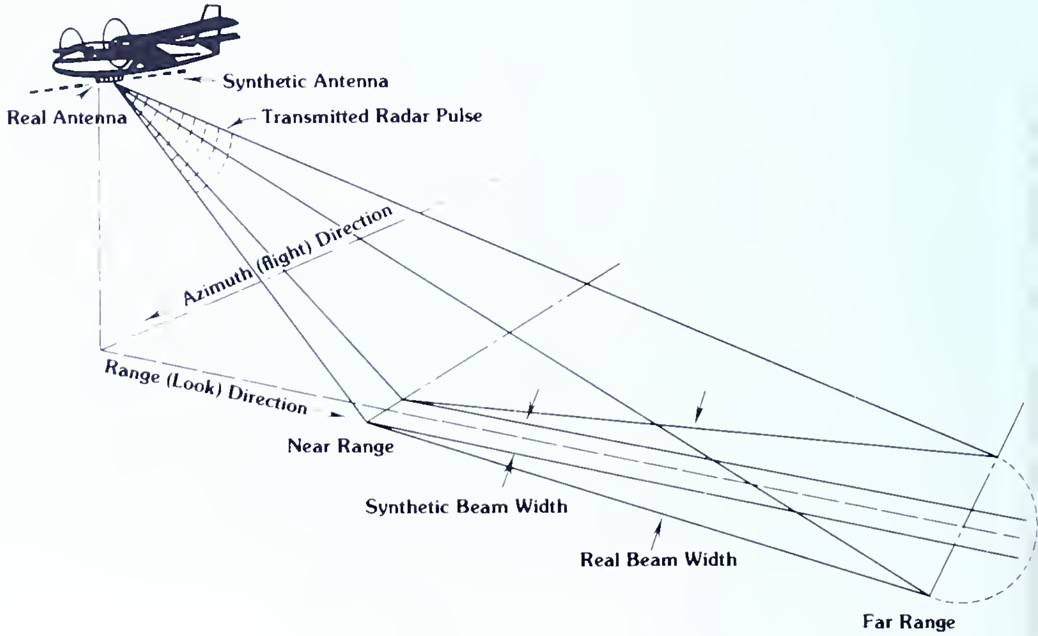
SLAR is particularly useful to earth scientists because it presents an enhanced image of surficial geology. Major and minor faults not visible at ground level can readily be located on the SLAR imagery.

Copies of the image mosaic can be purchased for $2.40 each from the Eastern Distribution Branch, U.S. Geological Survey, 1200 S. Eads Street, Arlington, VA 22202. Mail orders must specify "Harrisburg Radar Image Mosaic" and include checks or money orders payable to the Department of Interior-USGS. Orders for less than $10 must include an additional $1 for postage and handling.

Principles of Slar Imaging

Side-looking Airborne Radar (SLAR) is an image-producing system that derives its name from the fact that the radar beam is transmitted perpendicular to the side of the aircraft acquiring the data. Microwave energy reflected from the terrain is recorded on holographic film, photographic film, or on magnetic tape.

SLAR system geometry defines "azimuth direction" (along-track) as parallel to the flight path, and "range direction" (cross-track) as perpendicular to the flight path. Radar imagery is referred to as near-range (that half of the image swath closest to the flight path) and far-range (that half of the image swath farthest from the flight path). The radar beam is transmitted at a depression angle from the horizontal which becomes shallower from near range to far range across the image swarth. This changing depression angle results in features in the near-range portion of the image having shorter radar shadows than features of equal elevation in the far-range portion. Radar shadows occur where there is no return of microwave energy, for example, where the backslope of a terrain feature is obscured from the radar beam. The Harrisburg radar mosaic was prepared using only the near-range portions of the image swaths where radar shadows are shorter and less terrain detail is obscured. The look direction of a radar image refers to the direction to which the radar beam is transmitted. Both the look direction (or directions) and range of depression angles are chosen to enhance structural detail..



Synthetic-aperture systems improve azimuthal resolution over real-aperture systems by using sophisticated reception and information processing techniques. The special signal processing simulates the reception of a narrow radar beam of uniform width so that azimuthal resolution remains constant from near range to far range across the image swath.

ROCK CLIMBS

When rock climbers see a rock outcropping they look for routes to take them from the ground to the top. And they are not looking for the easiest route—often the preferred climb is the one with the most difficulty and the most challenge.

"Climb Pennsylvania", edited by Curt Harler, and published by LaSiesta Press of Glendale, California is a guide to the rock climbing areas of the state. The book discusses 38 rock climbing areas in the Commonwealth, as well as several bouldering areas, and offers a list of possible ice climbing sites.

Each climbing area includes a description of the type of climbing available, a brief geological identification, a listing of the more obvious routes and their climbing grade, and specific directions to the climbing area.

The geological information was drawn largely from material in print from the Pennsylvania Geological Survey, which is acknowledged by the editor.

The book is of interest to anyone who is involved in rock climbing, or to anyone who needs to find such exotic rock formations as A Champ's Chimney, Zombie, White Line Fever, or Poison Ivy. It is available at local outdoors shops for $2.50, from the publisher, or for $3.00 including cost of postage and handling, from the Pennsylvania Mountaineering Association, P. O. Box 4490, Harrisburg, Pa. 17111.

Caution is advised that rock climbing is a sport that requires training and experience. This book mentions sources of instruction and guidance in equipment for those interested.

Limestone Production In
Pennsylvania's Allegheny Plateau
ALLEGHENY MINERAL CORPORATION

Allegheny Mineral Corporation (AMC), a subsidiary of the Snyder Associated Companies, Inc., of Kittanning, Pennsylvania, operates two limestone-stripping quarries in Butler County and one in Armstrong County. Combined, these three operations mine in excess of 1 million tons of Pennsylvanian-age Vanport Limestone annually. AMC got it's start in the late 1950's as a quality high-calcium (90% $CaCO_3$) limestone producer. In addition to limestone production, other Snyder Associated companies dredge and mine sand and gravel in the Allegheny River drainage (Glacial Sand & Gravel Company) as well as produce fuels such as coal and gas (C. H. Snyder Company).

GEOLOGY AND MINING. AMC's largest and most diversified limestone operation is located about 1 mile NE of Harrisville, in Butler County. This facility was developed in 1958 and produces construction aggregate, agricultural limestone, and coal-mine rock dust, with a cumulative annual production of about 500,000 tons. Here, horizontal layers of Vanport Limestone occur; typically the Vanport is about 15 feet thick and consists of an olive-gray carbonate-mudstone containing occasional calcite "eyes" which may be related to minor marine fossil replacements. Some thin shaly partings, especially near the top of the limestone sequence, can be seen in the production faces. Typical bedding thicknesses range from 1 to 2 feet in most 14- to 16-foot-high faces. O'Neill (1964) reported a chemical analysis of 94.5% $CaCO_3$, 0.5% $MgCO_3$, 3.1% SiO_2, 0.5% $A1_2O_3$, and 0.5% Fe_2O_3 from a washed stockpile sample at this operation.

Bergenback (1964) postulated that the Vanport was deposited in a shallow ($<$40 feet) transgressive marine environment contiguous with, and related to, a deltaic environment of deposition (complete with coal swamps) about 315 million years ago. He also attributed much of the carbonate to a biochemical origin, such as an algal ooze.

Mining limestone within the Appalachian Plateaus Physiographic Province of western Pennsylvania (Figure 1) contrasts significantly with mining limestone in the Valley and Ridge or the Piedmont Physiographic Provinces of central and eastern Pennsylvania. Mining here requires sequential strip-mining cuts about

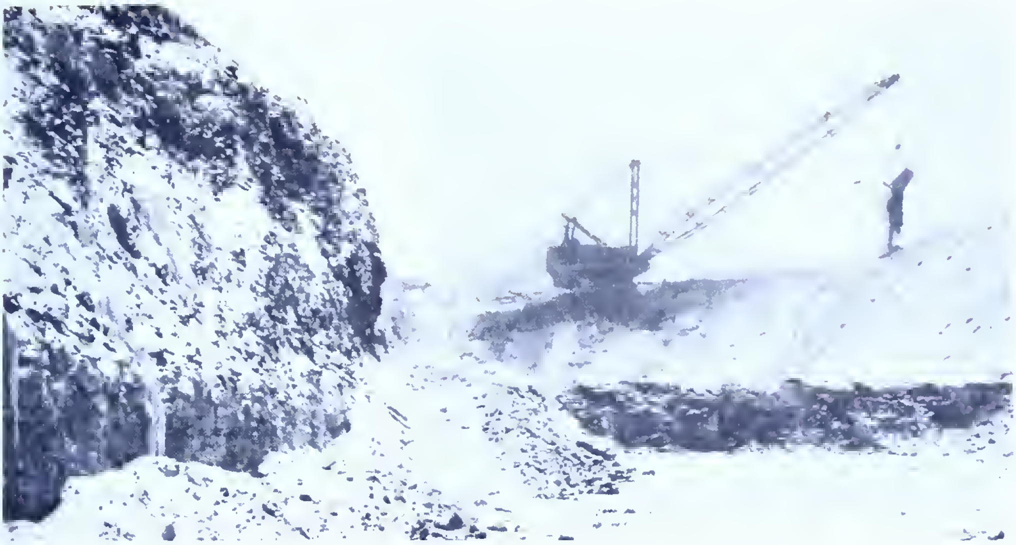


Figure 1. Partial view of a typical 1400-foot-long stripping cut at AMC's Harrisville operation. Face in the foreground is Vanport Limestone. Fifteen-cubic-yard dragline in the background is casting overburden.

4000 feet long, 100 feet wide (at depth), and about 100 feet deep (to the base of the Vanport). Annual production rates typically require mining 10 to 12 acres per year. (In the Valley and Ridge or Piedmont Physiographic Provinces, obtaining the same production from a 100-foot face would require mining less than 2 acres per year). Nevertheless, AMC's approximately 1500-acre site contains vast reserves.

Topsoil is removed with pans (earthmovers) and stockpiled for later reclamation. Overburden, with thicknesses typically ranging from 80 to 100 feet, is removed year-round with a 15-cubic-yard dragline. And the carbonate producers in central and eastern Pennsylvania think they have overburden problems! Stripping is initiated near the middle of the cut and worked in opposite directions, so that two working faces can be developed and to ease limestone haulage to the plant. Limestone production is generally limited to mid-March through mid-December. An 8- to 10-inch-thick coal (Lower Kittanning) occurs above the Vanport, and is selectively mined and stockpiled with a "Gradall" during winter months. This same machine is used to clean the top surface of the limestone in warmer seasons.

Limestone is transported to the plant by two 50-ton haul trucks and dumped into a 42 inch by 48 inch primary jaw crusher. Oversized material is reduced here with a hydralic ram, and product is con-

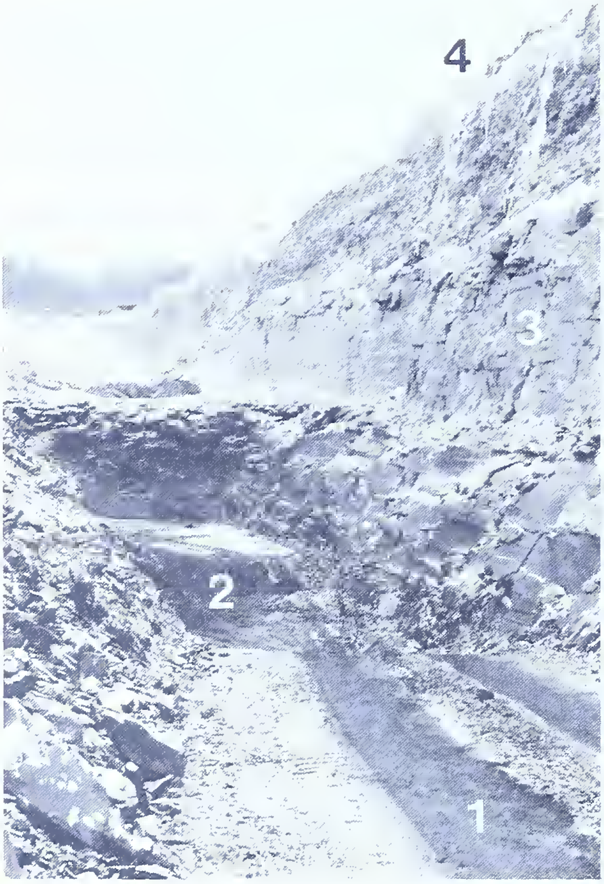


Figure 2.Multiple production face at the newly openned Worthington operation. Tracks in the foreground are near the top of the Clarion coal (1). Lowermost face in the pit floor is the Clarion coal (2). Massive light-colored rock in the face on the right is the Vanport Limestone (3). The base of the Lower Kittanning coal marks the top of the cut on the right (4).

veyed to a surge pile. Products, except quarry-run and rip-rap, are further washed and sized in a series of cone crushers, log washers, and screens. Various finished products are stored in bins from which they are transferred by truck to the appropriate stockpile. Year-round production of agricultural limestone and coal-mine rock dust (sprayed on the workings of underground coal mines to reduce combustion) is by a separate milling circuit. Here, two roller mills and an air classification system produce a finely ground product with a minimum of 70% passing through a 200-mesh sieve. These products are available in bulk and in 50-lb. bags.

A similar operation of the company, developed in 1974 and of approximately the same size (about 400,000 tons annually), is located about 1 mile SW of Slippery Rock, Pennsylvania, also in Butler County. The only significant difference between the operations is that no finely ground products are manufactured at Slippery Rock, which is the major rip-rap source for AMC.

About 1 mile west of Worthington, Pennsylvania, in Armstrong County, an additional, smaller operation was developed by AMC in

1985 primarily to supply raw limestone for clinker and mortar production to Armstrong Cement and Supply Corporation in nearby Cabot, Pennsylvania. At this operation, about 150 feet of overburden will be stripped to recover about 15 feet of Vanport Limestone. This additional overburden stripping cost is partial offset by the recovery of the superjacent Middle and Lower Kittanning coals and the subjacent Clarion coal (Figure 2). No plant or crushing facilities have been developed at this site. Keeping all this production in synchronization is a tribute to the skills of the mining and engineering department of AMC.

MARKETING. In general, construction aggregate from these operations is restricted to a 30-mile radius from the plants at Harrisville and Slippery Rock. Agricultural limestone typically has a 30-to 40-mile sales radius from the Harrisville plant, whereas coal-mine rock dust can travel up to a 90-mile radius from here. Rip-rap from the Slippery Rock operation has been sent as far as Erie, Pennsylvania.

We wish to than Mark A. Snyder and Mike Odasso of Allegheny Mineral Corporation for their cooperation in preparing this article.

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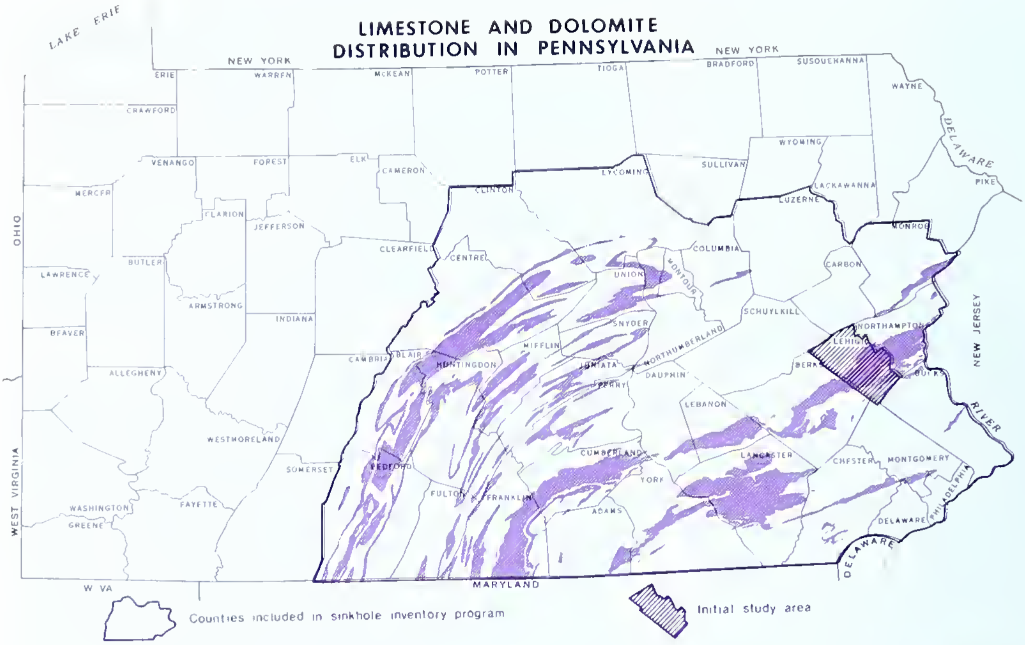
SINKHOLE INVENTORY PROGRAM BEGINS IN PENNSYLVANIA

The Bureau of Topographic and Geologic Survey has recently initiated a project to inventory sinkhole occurrence for those counties in Pennsylvania where limestone or dolomite are at the surface. Lehigh County is the first of 34 limestone-bearing counties which are to be inventoried. Environmental problems associated with sinkhole subsidence in the carbonate rocks of central and southeastern Pennsylvania have dramatized the need for greater understanding and information about weathering processes in carbonate bedrock and how these processes can affect property, business, and the individual.



Sinkhole in Saucon Valley, Lehigh County. Two sinkholes in the background have been filled.

The results of this project will be made available as Open-File Reports consisting of 7.5-minute topographic maps (scale 1:24,000) depicting known sinkhole occurrences, bedrock contacts, and structural data of each county. Along with the location of sinkholes, open-pit and deep mines, caves and other karst-related features will be shown.

Mapped sinkhole locations will be entered into the Survey's computer system by county, township, quadrangle (7.5'), and coordinates (latitude and longitude) for reference, service requests, and continuous up-dating of the database.

The Open-File Reports will be publicly announced and should be of considerable interest to county and municipal planning groups, engineers, state and federal agencies, and residents of the county in planning for construction and land use.

The inventory of Lehigh County will be conducted by staff geologist William E. Kochanov with completion planned for the end of May, 1986.

New Survey Publications

High-Purity Silica Report Identifies Previously Unknown Resources

A new reconnaissance investigation identifying previously unknown high-purity silica resources in Pennsylvania, has been released. This report includes chemical analyses and descriptions of nine Paleozoic formations and six quartz veins from 30 locations in 14 counties of central and eastern Pennsylvania. Percent $A1_2O_3$ and Fe_2O_3 are reported for both ascollected and beneficiated splits. Beneficiation consisted of hot acid baths and magnetic separation. The results for beneficiated samples suggest amounts as low as 60 ppm Al_2O_3 and <15 ppm Fe_2O_3 for quartz veins, and 230 ppm and 40 ppm respectively for some Cambrian-age sediments.

The purity (chemical and mineralogical), thickness, beneficiation potential, and possible uses for each sample are given, as are the resources available. High-tech users of silicon and lasca, in addition to glass, refractories, cement, metallurgical, proppant, and aggregate consumers and producers, should benefit from this description of silica resources in the Commonwealth.

Mineral Resources Report 88, *High-purity Silica Occurrences in Pennsylvania,* by Samuel W. Berkheiser, Jr., is available from the State Book Store, P.O. Box 1365, Harrisburg, PA 17105. When ordering by mail, send a check payable to the "Commonwealth of Pennsylvania" for $7.15 (plus $ 0.43 tax if mailed to a Pennsylvania address).

Geochips

We geologists get to see the balance of Nature almost every day. We're often blessed with examples of the order of things, especially when doing field work off the beaten track.

Some years ago, Bill Sevon, a Geologist in our Mapping Division, recounted an incident which was at the same time humorous, mildy frightening, and indicative of territorial imperative. He was mapping sandstones in Pike County, Pennsylvania. Bill entered an abandoned flagstone quarry on a hot summer afternoon, and began the usual geologist's routine of data gathering and note-taking. While sitting on a slab of flagstone examining his aerial photographs, he noticed something moving at the opposite end of the old quarry. A sizeable bear wandered into his view, apparently oblivious of a geologist's presence. The bear sat down, made himself comfortable, and began to survey the scene, seemingly an equal authority on rocks and the order of things. Not wanting to interfere with the brute's business, Bill made no move, but began to plan a silent, tiptoe exit. As the bear scanned the quarry, he finally recognized the presence of another of Nature's creatures, and froze to judge the seriousness of the situation. After a moment that seemed like an eternity to Bill, the bear apparently decided that this particular quarry was already occupied, and that it would be ill-mannered to interfere with the progress of science. In a fluid and silent motion, he arose on all four paws and tip-toed discretely out of the quarry. With a sign of relief, and grateful for that day's balance of Nature, Bill continued his gathering of data.

GEOCHIPS will be presented in the issues of *Pennsylvania Geology* during our Sesquicentennial year. As we celebrate 150 years of pondering the geology of the Commonwealth, GEOCHIPS will share some of the human side of our geologists' life at the Pennsylvania Geological Survey.

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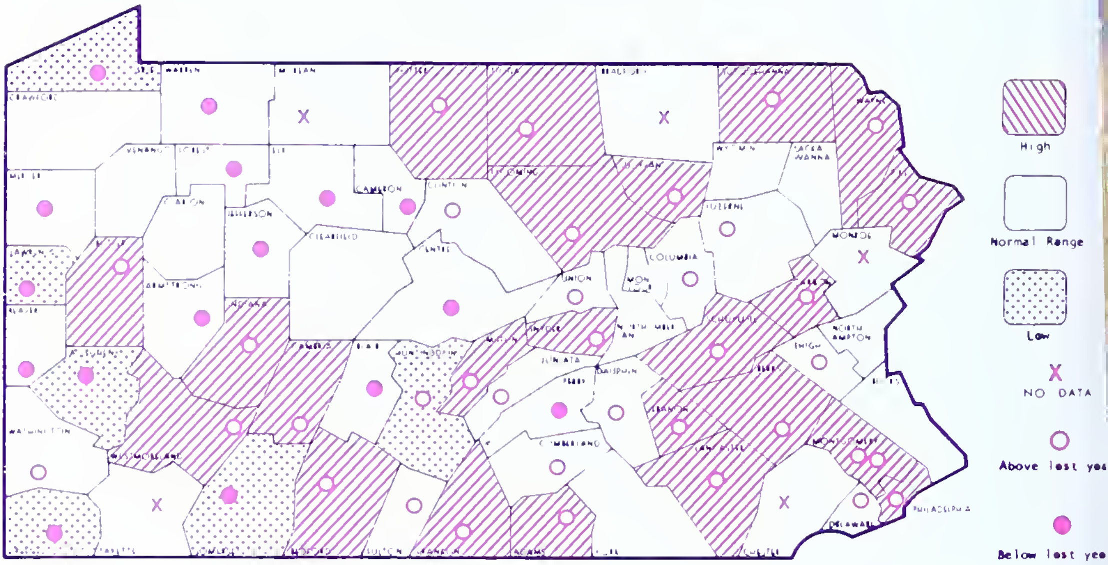

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ON THE COVER: Reproduction of a portion of a copper plate lithograph entitled "Pass of the Lehigh at Mauch Chunk", sketched by George Lehman, an artist employed by Henry D. Rogers in the 1840's to illustrate *The Geology of Pennsylvania, a Government Survey,* published in Philadelphia, Pa. in 1858.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania, 17120.

Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

VOL. 17, No. 3 **JUNE 1986**

FROM THE DESK OF THE STATE GEOLOGIST

SIGNING OFF - WITH THANKS TO ALL

This is my last column as the State Geologist of Pennsylvania. Having completed 29 years with the Pennsylvania Geological Survey and having been privileged to serve as Director and State Geologist for 25 years, I am retiring from those duties this August 6th. This being my valedictory statement, I hope you will bear with me as I reminisce. Since this publication, Pennsylvania Geology, was first issued in 1969 to keep you aware of geological developments in Pennsylvania, I have appreciated the opportunity to freely share my thoughts with you in these columns and I have welcomed the responses I have received from so many of you. I like to think of the nearly 5,000 readers of this magazine as family members who want to share in our activities and our progress. At this end the challenge has been to keep the articles lively, current, and respectful of the diverse interests of our readers.

As one who believes that science, and particularly geology, should relate to society and its needs, coming to the Survey from the academic community was for me not a drastic change. I have strived for our Survey to advance the knowledge of Pennsylvania geology in a manner that serves the broad spectrum of Pennsylvania citizens. Not unlike the academic community, this has called for scientific investigation, followed by effective communication of the results, utilizing format, content, and language that will enable the widest possible audience to benefit from the knowledge of the complex geologic environment which surrounds and impacts everyone. Our Survey has also maintained a long-standing policy that the results of each geologic project are promptly published so as to be available to the user public; maps and investigative results are of little benefit if they are only kept in relatively inacessible file cabinets.

At the risk of being immodest (what better occasion!) permit me to enumerate a few of the achievements here of the past 25 years. First, and most important for any manager, was the development and support of a highly competent staff, dedicated to quality work and to the geologic needs of Pennsylvania. As the staff doubled in size, we acquired highly qualified professionals who are a credit to the 150 year heritage of our Survey.

Towards the goal of effective communication, a number of innovations were received with acclaim. Breaking away from a long-standing practice of using dull, standard colors on geologic maps, we instituted contrasting, standout colors (the influence of my artist wife!) to highlight the geologic features and structural relationships on our maps; our striking, bright 1960 state geologic map set the geologic community buzzing and went up on walls throughout the country. This technique has since been emulated by many geologic agencies far and wide.

The innovation of a three-column legend on our detailed geologic maps has provided users ready access to the desired basic information on rock description, mineral and water yields, and engineering characteristics of each rock formation on the map. This has also enabled accompanying reports to be of reasonable and economical length.

The range of our publications was broadened to reflect my belief that geology can serve all walks of life. To supplement our basic technical reports used by industry and professionals, we developed a series of publications for mineral and fossil collectors, hikers, and spelunkers; a series of geological state park guides; an environmental geology series emanating from our newly designated Environmental Geology Division; a series of page-size geologic maps and an educational series of geology booklets which annually has been going out to over 100,000 requesting students, scouts, and clubs. The rock and mineral sets we provided to teachers and students in the 1960's and early 1970's were a tremendous hit, but outstripped our capacity when the demand exceeded 20,000 per year.

Complementing our geologic project work, I have placed emphasis on geologic services to fellow state agencies, local governments, industry, consultants, schools, and the general public. Our annual list of callers has grown to thousands and reads like a who's who of Pennsylvania. Such service represents the application and utilization of the geologic knowledge acquired in our project work and is a reflection of the pertinence of our geologic activities.

Over the past 25 years our Survey has taken on many new responsibilities as the role of geology has received wider recognition. Our involvement has grown to include such environmental issues as waste disposal siting, municipal water resources development, geologic hazard mitigation (landslides, sinkholes, radon), and energy resources extraction while minimizing their environmental impacts. The ever-changing applications and needs for geologic data has kept the work environment here dynamic and challenging; truly, never a dull moment.

Our staff is now rapidly adapting to the benefits of computer technology. Keyboards, terminals, and printers in our midst represent new tools which will provide a major step forward in retrieval, correlation, and interpretation of the mass of geologic data which has been acquired over the years. And while some of us old-timers may fret and mutter choice words when these computers develop "bugs" and "crashes", I have to concede they are tremendous assets as supporting tools.

I wish to extend sincere thanks to the U.S. Geological Survey for continuing to carry on the cooperative programs in geology, water resources, and topographic mapping which were initiated long before my time and whose products have been of great assistance in fulfilling the needs of our Survey and the citizens of Pennsylvania. Ours was one of the first large states to have completed topographic map coverage of the state as a result of the co-op program with the U.S.G.S. Similarly, the co-op groundwater investigations have covered large areas of Pennsylvania. By now my U.S.G.S. colleagues know that when I prod them its because we like their efforts so much we want more! The U.S. Bureau of Mines has also been of important assistance over the years in our work with mineral resources. May these federal support programs continue long into the future!

I am particularly appreciative of the support and confidence provided to me by the seven agency heads I have served under over the past 25 years. Secretary of Internal Affairs Genevieve Blatt was (and is) a staunch supporter of the Survey and our policy to expand its efforts and services. Following her were Secretaries John Tabor, Irving Hand, and Environmental Resources Secretaries Dr. Maurice Goddard, Cliff Jones, Pete Duncan, and currently, Nick DeBenedictis. Each provided welcome support and encouragement to the programs and activities of our Survey.

As 1986 is the 150th anniversary of the founding of the Pennsylvania Geological Survey, I feel proud and privileged to have served as the eighth State Geologist of this distinguished organization. I am confident that it will have a long and healthy future. There will be changes, as there should be for the sake of progress. There is much work yet to be done here in Pennsylvania and the role of geology is ever evolving. Therein lies the excitement and the challenge of the Pennsylvania Geological Survey.

To my successor, to the Pennsylvania Survey, and to all of you kind readers, I extend my sincere best wishes.

Arthur A. Socolow

A Sesquicentennial Story

SUSQUEHANNA RIVER WATER GAPS: MANY YEARS OF SPECULATION

by W. D. Sevon
Pennsylvania Geological Survey

The Problem

The Susquehanna River water gaps north of Harrisburg (Figure 1) have probably inspired more speculation about their origin than any other feature of Pennsylvania landscape. The five impressively scenic water gaps sever imposing, elongate, uniform ridges of resistant rock in apparent defiance of proper stream behavior; that is, the Susquehanna River has cut through the ridges in places which logic suggests could have been avoided by lateral stream migration. Theories about the position of the gaps have been numerous and imaginative.

Some Historical Solutions

The first theory about the water gaps, derived from near folklore of the early 1700's, suggested that the gaps were formed when oceanic waters, which existed as large lakes dammed by the mountain ridges subsequent to uplift of the land above the general level of the sea (possibly the Mosaic flood), burst forth in a catastrophic fashion and cut the water gaps to their present form (Miller, 1939, p. 13–24).

Henry D. Rogers, geologist of the First Geological Survey of Pennsylvania, attributed the erosion of the gaps to paroxysmal movements of oceanic waters during mountain building and the location of each gap to erosion at a position of weakness created by a transverse fault (1858, v. 2, p. 895–897).

Literature of the Second Pennsylvania Geological Survey is largely descriptive and few words are devoted to origins. Claypole (1885, p. 21–23) visualized the downcutting of the Susquehanna River as a slow, lengthy, and continuing process, but said nothing about the location of the water gaps.

William Morris Davis, in his classic paper "The rivers and valleys of Pennsylvania" (1889), attributed the location of the gaps to the circumstance of superimposition. He hypothesized that long-

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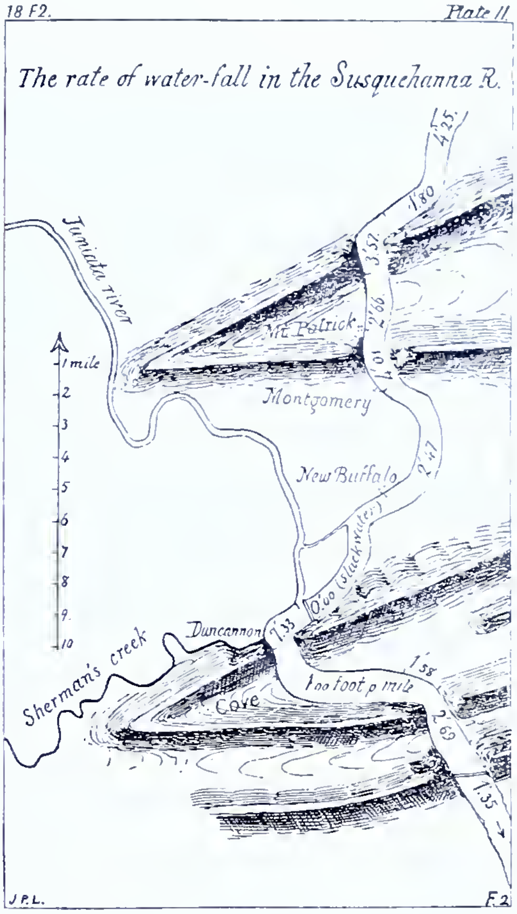
*Celebrating 150 years of The Pennsylvania Geological Survey—1836 to 1986.

Figure 1. Map of the Susquehanna River water gaps north of Harrisburg and the linear ridges through which they cut (from Claypole, 1885, p. 18).



continued erosion in the Appalachian Mountains produced the Schooley peneplain: a relatively flat, continuous surface, now evidenced only by the crests of the linear ridges (Figure 1). The ancestral Susquehanna River meandered across this surface. Uplift and rejuvenated stream erosion caused river incision at locations unrelated to structural position.

Johnson (1931) also relied on circumstance to account for the gap locations, but by a slightly different mechanism. Johnson hypothesized that a marine transgression occurred across a peneplain surface into the central part of Pennsylvania during the Cretaceous. Deposition of a blanket of sediments supposedly occurred, the sea regressed, and the consequent drainage developed on the sediment surface established some of the stream positions we see today. Thus, as the unconsolidated coastal-plain sediments were eroded, Johnson thought that the major rivers, such as the Susquehanna, maintained a course across the trend of the underlying folded rocks.

Subsequent workers Meyerhoff (1936; 1972) and Thompson (1949) suggested that the gap locations are related to a variety of rock weaknesses or structural positions, but that the course of the river results from gradual headward erosion over a long period of time. Epstein (1966) has argued for structural control of other water gaps in Pennsylvania, and Theisen (1983) recently documented structural weakness in Blue Mountain at the Susquehanna River water gap. Neither worker offers any suggestions as to how rivers establish themselves in these special positions.

A New Proposal

I have argued elsewhere (1985a, b) that neither peneplanation nor a Cretaceous transgression has occurred in the Appalachian Mountains. Because new structural interpretations in southeastern Pennsylvania are considered by some to indicate that the Anthracite basins were once covered by a thrust sheet (Levine, 1985; MacLachlan, 1985), I suggest that following Alleghanian deformation the ancestral Susquehanna River flowed north along the margin of the Anthracite thrust sheet (Figure 2) and established the basic course of the river we see today. The flow direction was reversed from north to south by a process of headward erosion and stream piracy. The specific location of each water gap was determined by local structural features (Hoskins, 1986). Once the Susquehanna River was incised into the very resistant rocks which form the linear ridges, the river was locked into position and could not migrate laterally.

There you have it. Over 150 years of speculation has not resolved the question. Are we getting closer to or farther from the truth?

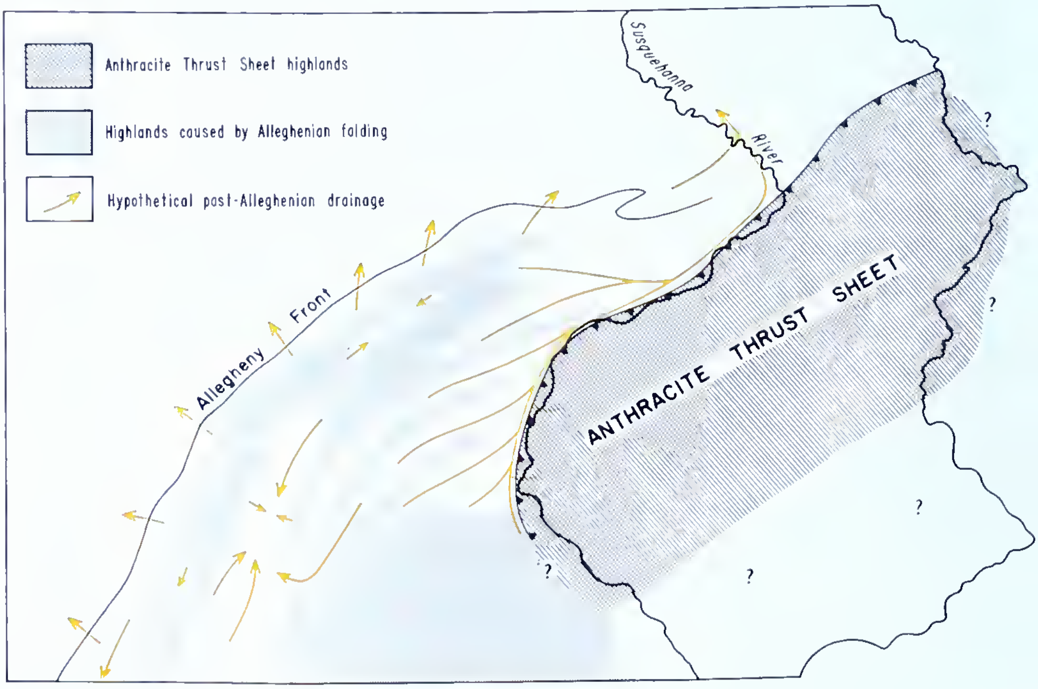

Anthracite Thrust Sheet highlands
Highlands caused by Alleghenian folding
Hypothetical post-Alleghenian drainage
Susquehanna
River
Allegheny
Front
ANTHRACITE THRUST SHEET
?
?
?
?
?

Figure 2. Hypothesized highland areas and drainage network in central and eastern Pennsylvania following Alleghanian deformation.

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NEW U.S.G.S. ADDRESS FOR ORDERING TOPOGRAPHIC MAPS

Effective July 1, 1986, the U.S. Geological Survey is consolidating its Eastern and Western Distribution Sections. All maps must be ordered from:

U.S. Geological Survey
Map Distribution
Federal Center, Building 41
Box 25286
Denver, CO 80225

CONTINENTAL CLAY COMPANY
A PART OF PENNSYLVANIA'S MINERAL HERITAGE SINCE 1896

Continental Clay Company of Kittanning, Pennsylvania is the sole surviving United States producer of radial chimney bricks. This type of industrial brick chimney is a common landmark throughout North America. The orange and white aircraft warning bands often seen atop these chimneys are achieved with special glazes developed by Continental Clay. Recently, Continental Clay has been working with various glazes to match the chimney on Ellis Island that is being restored by the National Park Service. The original chimney was built of bricks that came from Germany, and was undoubtedly one of the first sites seen by newly arriving immigrants to this country.

Continental Clay Company has been mining and manufacturing tile and brick products continuously for the past 90 years. Around the turn of the century, according to Henry J. Evans, III, General Manager, most large towns in western Pennsylvania tried to establish two essential industries: a brick plant and a brewery. Kittanning was blessed. At one time, it harbored four brick plants and the now defunct Elk Brewing Company, which is now located on Continental's property. In addition, Armstrong County and Kittanning were well served by railroads and by water transportation via the Allegheny River.

International Chimney Corporation, of Buffalo, New York, the parent company of Continental Clay, purchased Continental Clay Products Company in 1979. Prior to this, three generations of the McNees family worked local clays and shales from underground as well as surface mines for brick and tile manufacture.

GEOLOGY AND MINING. The traditional source of light-colored clay products is from underground workings developed in the Pennsylvanian-age Clarion underclay interval (J. Claycomb, personal communication, 1986). The current service incline and tipple are located about 1400 feet north of the office (Figure 1). An older, sealed adit is said to be near the still-standing mule barn next to the office. Present active underground mining is located about 4000 feet northeast of the incline. Here, about 4.5 feet of basal medium- to light-gray claystone and about 2 feet of upper brownish-black claystone constitute the mining interval. The two distinct claystones are separated by a black claystone band, up to 2 inches thick, used as

Figure 1. Mr. Joel D. King, Mine Superintendent, and Mr. Keith Bruner, Mine Foreman, standing in front of main service incline. Sign on door reads "Continental Clay Company, since 1896 the world's finest clay has been mined here."

a marker bed throughout the mine. A thin (6- to 8-inch-thick) coal, possibly Clarion (Leighton and Shaw, 1932), can occasionally be seen in the mine roof, especially along north-trending main haulage ways or cross cuts, where roof falls have exposed an additional 5.5 to 7.5 feet of stratigraphic section (Figure 2).

The underground workings are extensive (>100 acres); however, adequate reserves remain. Conventional room-and-pillar mining is used with 12-foot-wide rooms developed on 60-foot centers. Typically, rooms are oriented in an east-west trend. Development faces are drilled with a diesel-powered electric hand drill. Haulage to the surface tipple is with about seven 1-ton rail cars powered by an electric locomotive. The loaded cars are winched up the final tipple incline. Mine production, when needed, is about 70 tons per day in one 7:00 a.m. to 3:30 p.m. shift.

In addition, two surface strip pits currently supply supplemental Pennsylvanian-age shale for red-colored brick and tile products. About 18 feet of a yellowish-gray to light-olive-gray, micaceous, shaly mudstone and a subjacent 15 feet of brownish-black, micaceous, thinly laminated mudstone and claystone are mined about 0.75 mile west-southwest of the office. This sequence is believed to be in the

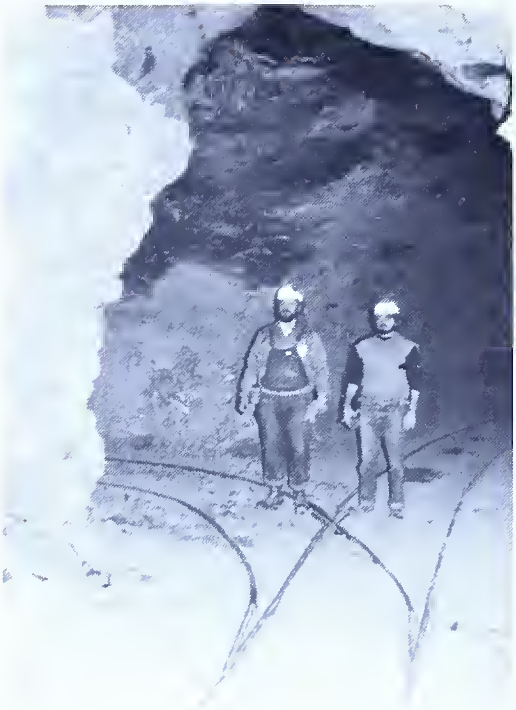

Figure 2. The Clarion underclay interval in the main haulage, where a total of 12 to 15 feet of section is exposed. Note the lighter claystone beneath the darker claystone in the far rib to the left.

lower part of the Glenshaw Formation of the Conemaugh Group (Berg and Dodge, 1981). A second source is mined in Westmoreland County near the village of Sardis, located about 25 miles south-southwest of Kittanning. Here, about 35 feet of moderate-olive-brown to pale-brown claystone, with minor grayish-red interbeds, is exposed on the south side of Pa. Route 286. This has been mapped as the basal Casselman Formation of the Conemaugh Group (Wagner and others, 1979).

MANUFACTURING. The plant in Kittanning is similar to one described by Berkheiser and Inners (1984) and follows the same basic process, only with less automation. Raw material is fed to a primary roller crusher and further reduced in size by two dry pans. This is followed by sizing over a series of screens after which the product is fed into two pugmills. Extrusion through the appropriate dies is followed by a reel-type wire cutting operation. Some structural tile and brick products pass through the glazing line (colored coatings are applied here). Individual unfired clay products are hand loaded onto kiln cars for a trip through one of 17 tunnel driers. These driers are kept at about 135°F by waste heat, and the bricks may spend from 2 to 5 days here depending on the end-product. Moisture content is brought down to less than 2% by preheating the product before it enters the gas-fired 420-foot-long tunnel-kiln. Temperatures in the 32-car tunnel-kiln range from about 400°F at the entrance to about 2275°F in the burn zone. Twenty-four-hour production varies between 8 and 12 kiln cars, depending on the product being fired. After cooling, products are unloaded and packaged for shipment by hand. About 45 to 50 employees are required during production, which is carried on during warm weather to substantially save on fuel bills.

CONCLUSION. Continental Clay Company is rich in mining heritage and has survived the test of time by filling small custom made product niches in the brick and tile industry. As one of Pennsylvania's oldest continuously worked mining companies, the company and its employees are recognized for providing quality handcrafted products in the industrial minerals field.

We are indebted to Mr. Henry J. Evans, III, General Manager, Mr. Joel D. King, Mine Superintendent, and Keith Bruner, Mine Foreman, of Continental Clay Company for their time and cooperation in preparing this article. We also thank Mr. Bill Bragonier and Ms. Joan Claycomb of R&P Coal Company for helping to identify the underground mining interval.

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New County Coal Resource Reports

The Bureau of Topographic and Geologic Survey has released for sale three new county coal-resource reports. The reports, compiled by staff geologists Clifford H. Dodge (M 89 and M 90) and James R. Shaulis (M 91), are three of many that will be published over the next few years for the major bituminous-coal-producing counties in western Pennsylvania. The new coal-resource reports each contain maps showing coal crop lines, surface and deep mined-out areas, and structure contours.

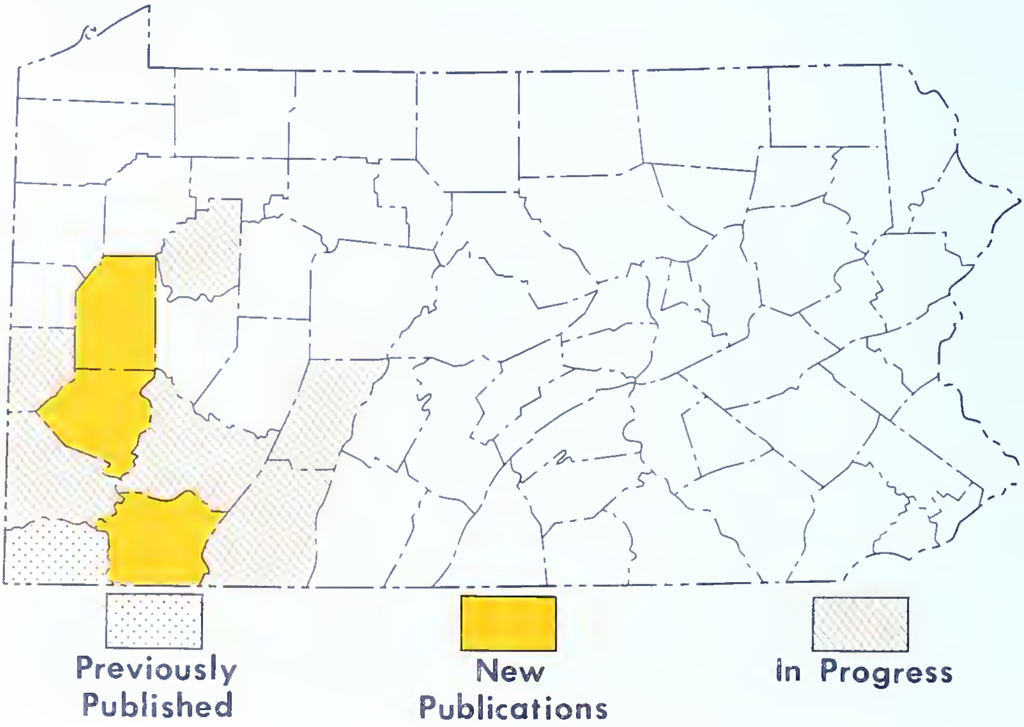
For each of the principal coal seams in each 7½-minute topographic quadrangle in the three counties, there is a map showing (1) the coal outcrop (crop line); (2) areas where the coal is known to be absent because of seam discontinuities; and (3) the extent of all known strip and deep mining up to the time of compilation. In addition, for each quadrangle, there is a composite coal crop map that includes structure contours and fold axes. If none of the principal coals have been mined or crop out in a particular quadrangle, only the second kind of map is included. The two-color maps contain information on sources of published and unpublished data, map reliability, map symbols, map scale (approximately 1:62,500), structure-contour intervals and datums, and names of fold axes. Each report is published as a package of 8½- by 11-inch, pre-punched sheets that will fit standard three-ring binders for convenient use in the office and field.

The publications are available from the State Book Store, P. O. Box 1365, Harrisburg, PA 17105. Prices are:

	Mail	*Over the counter*
Mineral Resource Report 89, Part 1 (Allegheny County)	5.90	5.15
Mineral Resource Report 90, Part 1 (Butler County)	8.55	7.80
Mineral Resource Report 91, Part 1 (Fayette County)	6.65	5.80

Plus 6% sales tax for Pennsylvania residents

A check made payable to the *Commonwealth of Pennsylvania* must accompany the order.



Pennsylvania's 1984 Oil and Gas Developments

In 1984, Pennsylvania's oil and gas industry reported 2,598 wells drilled, a small increase over 1983. The year's total included 1,073 oil wells, 1,379 gas wells, 40 combination oil and gas wells, 60 dry holes, and 46 service wells. The average depth in all wells reported was 2,410 feet. The industry produced 4,824,966 barrels of oil and 166,342 million cubic feet of gas in 1984, for a total value of almost $674 million dollars to industry. Recoverable reserves for oil decreased to 57,859 million barrels, but for gas reserves increased to 1,854,477 million cubic feet. Some of the interesting exploratory and development activity reported included expansion of the Upper Devonian Council Run field in Centre County, and the discovery of the Greenley pool in Erie County. Greenley pool is especially notable because it appears to be a southwestern extension of the fault-controlled Bass Islands play that has kept drillers interested in New York over the last several years.

If this information is interesting or important to you, you will want to obtain a copy of Progress Report 198, *Oil and Gas Developments in Pennsylvania in 1984,* recently issued by the Bureau of Topographic and Geologic Survey. The report includes information on many aspects related to oil and gas in Pennsylvania, including oil and gas prices and drilling costs, secondary and tertiary oil recovery projects, projects in progress at the Survey's Oil and Gas Geology Division, and a summary of the new oil and gas bill that was signed into law in December 1984.

Copies of this report are available from the State Book Store, P. O. Box 1365, Harrisburg, PA 17105 for $2.85 plus 6 percent sales tax for Pennsylvania residents. Checks made payable to the *Commonwealth of Pennsylvania* must accompany the order.

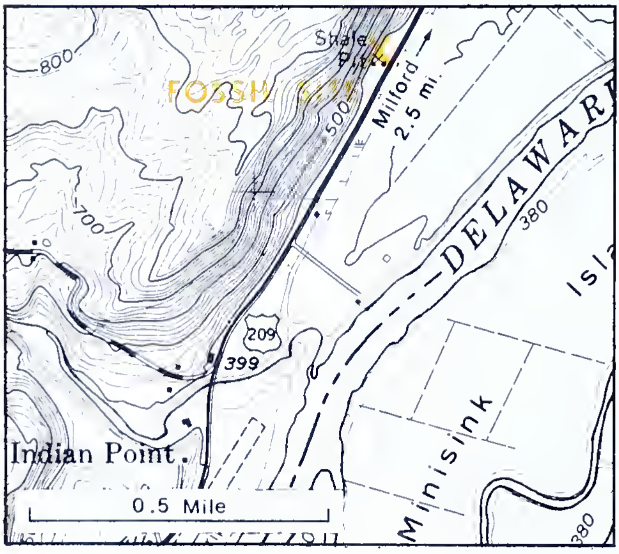
A CONULARID FROM THE MAHANTANGO FORMATION: FIRST DOCUMENTED REPORT

by John M. Kasznica
Delaware Valley Paleontological Society

Many invertebrate fossils found in the Paleozoic rocks of Pennsylvania are the remains of mysterious organisms whose biological affinities are a matter of controversy. Among these are the conularids—small, elongate-pyramidal marine fossils that have distinctly striated, chitinophosphatic shells. Although the conularids appear to have no living relatives, most paleontologists believe that they are an offshoot-branch of the class Scyphozoa ("jellyfish") of the phylum Coelenterata. Some widely used textbooks (Moore and others, 1952; Clarkson, 1979) reject or question this classification and instead consider the conularids part of an extinct phylum.

Whatever their "genealogy," the conularids occur in marine strata that range in age from Early or Middle Cambrian to Early Triassic (or in rocks approximately 570 to 220 million years old). In the Devonian of the Appalachian basin, one species (*Conularia undulata* Conrad) is quite common in the Hamilton Group (Middle Devonian, Erian Stage) of New York State. Conularids are little known, however, from the stratigraphically equivalent Mahantango Formation of Pennsylvania. Previous reports of conularids from this formation have either been proven wrong (see Ellison, 1965; Babcock, 1985) or were cursory (see Hoskins, 1964). This paper is believed to be the first documented report of a Mahantango conularid in Pennsylvania.

A fragment of a conularid (presumably *C. undulata*) was collected by the author from Mahantango siltstone rubble at an abandoned borrow pit about 2 miles southwest of Milford in Pike County (lat. 41°17′42″N/long. 74°49′45″W, Milford quadrangle; Figure 1). (See Hoskins and others, 1983.) The piece of "sharpstone" containing the fossil probably came from the middle member of the Mahantango, the rock unit that forms "The Cliff" along the northwest side of the Delaware River valley in this area (Fletcher and Woodrow, 1970).



NOTE THAT THIS PIT AND ALL OTHERS ON U.S. ROUTE 209 BETWEEN BUSHKILL AND MILFORD ARE NOW PART OF THE DELAWARE WATER GAP NATIONAL RECREATIONAL AREA; FOSSIL COLLECTING ON THIS FEDERAL PROPERTY IS STRICTLY PROHIBITED.

Figure 1. Location map.

The conularid specimen is an incomplete, compressed natural cast in medium-gray siltstone (Figure 2). One side is slightly damaged, and the apical portion is missing. Its exposed dimensions are 1.5 cm long by 1.5 cm wide by 0.5 cm "thick." The visible portion of the shell is shaped like an elongate pyramid with two partially exposed lateral faces. A well-defined furrow marks a corner between two quadrilateral faces, and a median longitudinal groove (parietal line) is just discernible on the right lateral face (see Figure 2). The lateral surfaces are covered with fine transverse striae that have a definite corrugated pattern. Reconstruction of the entire shell suggests that it measured 3.5 cm long and 2 cm in diameter. Since this is relatively small for *C. undulata* (see Hall, 1879), perhaps the specimen is a juvenile form.

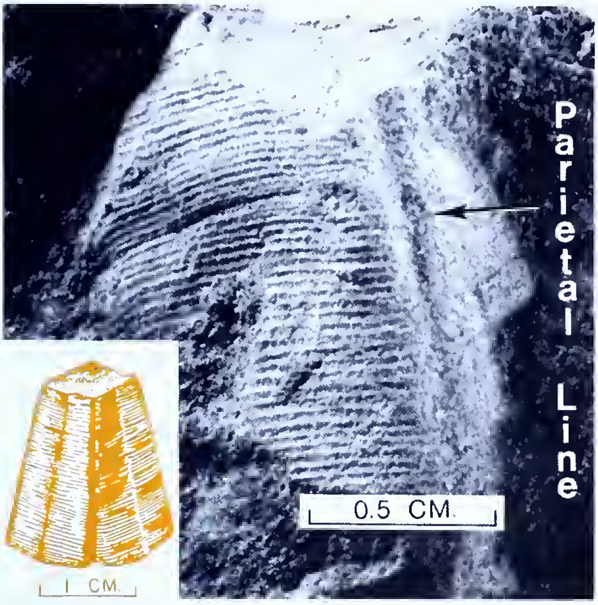


Figure 2. *Conularia* sp. cf. *C. undulata* Conrad from the Mahantango Formation in Pike County. Inset shows a partial reconstruction of an uncompressed specimen; note the quadrangular outline.

Like their phylogeny, the mode of life and environmental tolerances of conularids are conjectural. They are generally interpreted to have been sessile-benthonic as juveniles and nektoplanktonic as adults (Moore and others, 1952; Shrock and Twenhofel, 1953). All juvenile conularids apparently lived attached by the pointed apical end, but in many species the adults seem to have broken loose and become free-moving (Figure 3). In normal marine rocks, conularids usually occur sparingly in company with more numerous corals, brachiopods, bryozoans, mollusks, and arthropods; however, they may be the dominant organic remains in deposits representative of some unusual environments, e.g. certain phosphate-rich, Pennsylvanian black shales in the central United States (Moore and others, 1952). Since the

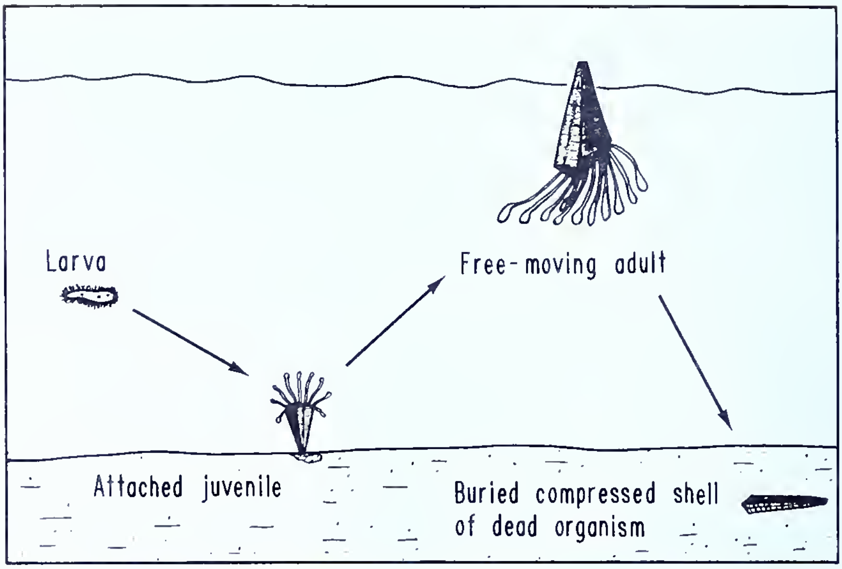


Figure 3. An interpretation of a conularid life cycle. The adult orientation is hypothetical.

Mahantango specimen described here was found in rubble, little is known of its ecologic association. An increased understanding of these creatures in the Devonian rocks of Pennsylvania awaits the discovery of more complete, in-situ specimens.

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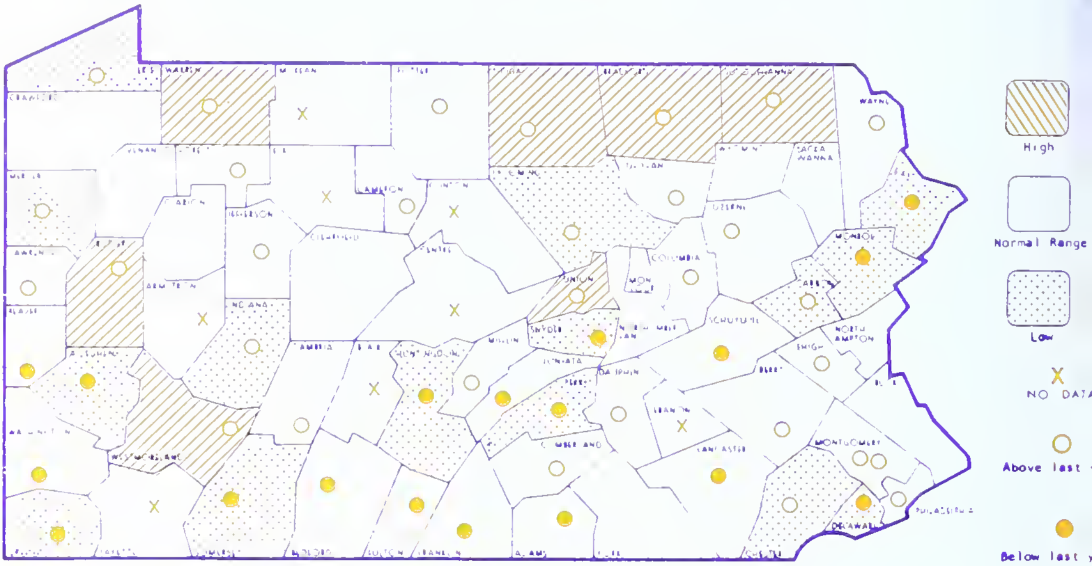

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Vol. 17, No. 4
Aug. 1986
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PENNSYLVANIA GEOLOGY

PENNSYLVANIA GEOLOGICAL SURVEY
150TH ANNIVERSARY
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TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, State Geologist

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ON THE COVER: Arthur A. Socolow, Eighth State Geologist of the Pennsylvania Geological Survey. Photo by Carl Socolow.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania 17120.

Editor, Arthur A. Socolow; Associate Editor, Donald M. Hoskins.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

VOL. 17, No. 4 **AUGUST 1986**

“QUOTES”

FROM THE DESK OF THE STATE GEOLOGIST

Although Arthur Socolow assumed that his words in the “FROM THE DESK OF THE STATE GEOLOGIST” page of *PENNSYLVANIA GEOLOGY* published in last month’s issue would be his valedictory–we thought otherwise. Rather than attempt to emulate his ability to make incisive, timely, and interesting comments on the geologic scene, we decided that some quotes from previous “FROM THE DESK...” columns would be a more appropriate post-valedictory.

Starting in 1976, our files show that the “FROM THE DESK...” page brought forth many comments. In some years nearly each issue of *PENNSYLVANIA GEOLOGY* resulted in letters and telephone calls agreeing with and complimenting the State Geologist’s writing. However, it is the written comments that perhaps best indicate the value of his commentaries. It is easy for a colleague or other reader to compliment by telephone, but when one is sufficiently motivated to put the same remarks in writing we can assume that the writer was more deeply affected by Art’s statements.

Comments were received from many readers such as geologists, engineers, consultants, etc. who would be expected to respond favorably to a fellow scientist. But many also came from non-technically trained persons such as legislators, educators, and government officials at the state and local level. Both the present Pennsylvania Lt. Governor, William Scranton, and former Lt. Governor, Ernest Kline, found time to write Art in response to a particular “FROM THE DESK...”

We have selected excerpts from four that produced the most comment; two of which were reprinted.

The first is from October, 1977 and was reprinted by the Milton Standard of Milton, PA.

“LEAD TIME — RHYMES WITH NEED TIME”

“In discussions which have taken place amongst the proponents of various proposals to cope with our nation’s energy problems, one aspect frequently tends to be overlooked, namely, lead time. That is the length of time that elapses from the time a decision is made to pursue a certain course of action, until the time when that action can be fully completed and implemented...

"While there is much talk of greatly expanding coal production, to develop a significant new coal mine from the point when a decision is made to do so until production actually starts generally involves between 5 to 10 years...

"The point to this discussion is simply that there are no quick solutions to drastically improve the nation's energy self-sufficiency..."

The October, 1978 "FROM THE DESK..." brought forth the most written comments. As some of us may have observed in recent years not much has changed since Arthur wrote these words.

"WHY NOT SUPPORT THE BASICS?"

"A few weeks ago a staff member of one of the federal agencies came up from Washington. He had called previously to invite our Survey to apply for federal money which was available for a specified type of research. My phone reply was apparently so incredulous to him that he asked to come and explain in person the available monies. After hearing him (and his two colleagues) out, I again replied that the type of exotic research he was urging us to undertake was extremely unlikely to be fruitful within the geological framework of Pennsylvania and, therefore, my responsibility as State Geologist and my conscience as a taxpayer would not permit me to go after this earmarked federal money...

"...While there seems to be federal money available for exotic research projects, there is little or none available for basic resource mapping and data collection. Yet in geology, as in other sciences, the fact is that major advances and breakthroughs have to be built on a base of hard data, accumulated through years of tedious, non-glamourous field and laboratory work..."

In June of 1980 nearly as many comments were received as a result of the following "FROM THE DESK...":

"ACHIEVEMENTS YES, APOLOGIES NO"

"There are some who have been saying in recent years that the United States, with approximately 6% of the world's population, has no right to be consuming some 30% of the world's annual production of mineral resources...

“America’s technological and scientific genius which has created the marvels of transportation, communication, housing, disease controls, and scientific agriculture should also not be asked to apologize for their achievements, even as they too have added to our consumption of resources.

“The challenge to our society is not simply to consume less out of some sense of guilt. We should rather eliminate wasteful procedures...

“The underdevelopment nations have every right to aspire to greater use of mineral resources, greater industries, and high standards of living. But the challenge to those nations is to take the initiative to find and develop the resources in their own back yard. Our national achievements or our levels of consumption are not the cause of their underdevelopment and underconsumption....

“Yes, our country is a major consumer. Yes we have challenges to face in order to sustain our standards of consumption. Those challenges call for achievements, not apologies.”

And lastly, comments to which all who value the worth of a basic scientific report can relate.

“SO WHAT’S THE WORTH OF A GEOLOGIC REPORT?”

“...How important is a geologic report? How much is the report worth if it enables the highway department to pick a route that saves millions of dollars in construction costs? What’s the value if the report identifies the location of mineral deposits needed to provide lime for the farmers, clay for the brickmakers, or coal for the steel industry? To justify its existence, how many copies of a geologic map must be sold which shows the location of geologic faults hazardous to nuclear power plants and the location of sinkholes hazardous to schools and dams? How do you assess the value of a geologic report which identifies the location of groundwater needed to locate a new glass factory employing hundreds, or a sprawling, new multimillion dollar bottling operation? If our reports lead to natural gas occurrences that heat our homes, and dam sites that keep them from being flooded, must we sell as many copies as *Gone With the Wind* to justify their existence?...

“...Whether they provide mineral raw materials for our industries, locate the waters needed for our survival, identify the geologic hazards that can ruin us, or assist the roadbuilders, farmers, and recreation planners, our geologic reports measure up well to the test of time and value.”

CHARLES H. BEHRE, JR.
1896-1986

With the death of Dr. Charles H. Behre, Jr., at age 90 last February 18, the geologic community lost a distinguished scientist and the Pennsylvania Geological Survey lost a one-time colleague and long-time supporter. Personally, I lost a friend and mentor who, as my major professor, guided and encouraged me during my graduate studies at Columbia University. All who came in contact with Charles Behre were awed by this dear, gentle soul who in his own quiet and polite manner provided creative inspiration. He also demonstrated the importance of relating the cold facts of science to the needs and concerns of humanity. Truly, Charles H. Behre, Jr., was a great teacher and an outstanding scientist. Never was the phrase, a gentleman and a scholar, more apt.

Born in Atlanta, Georgia, Charles Behre received his B.S. and Ph.D. degrees in geology from the University of Chicago. After serving in World War I he joined the Pennsylvania Geological Survey as a cooperating geologist and began his teaching career at Lehigh University. It was in those years that he conducted his detailed field and laboratory studies of the Martinsburg slate belt in eastern Pennsylvania which resulted in the classic Mineral Resource Report 16, *Slate in Pennsylvania,* still considered the most definitive exposition on the subject.

Subsequently, Charles Behre taught at the University of Cincinnati, Northwestern University, and Columbia University where he served as Chairman of the Department of Geology. In addition to his academic duties, in 1946 he founded the internationally recognized consulting firm of Behre, Dolbear and Co. where, until his retirement in 1971, he served as mineral advisor to the governments of Burma, Haiti, and Algeria. He was a member and officer of all the major geological societies and recipient of distinguished national and foreign awards and citations too numerous to mention here.

We note Charles H. Behre's passing with appreciation for his many contributions and fond memories of his friendship.

Arthur A. Socolow

GEOLOGICAL RESEARCH IN PENNSYLVANIA

1986

INTRODUCTION

This publication is the twenty-ninth annual report on Geological Research and Publications in Pennsylvania. It is an attempt to list all current geologic research in Pennsylvania and includes reports of persons and projects other than those of the staff of the Pennsylvania Geological Survey. Because of the large number of projects reported to us, we editorially condense the description of the research projects to fit available space.

We have also requested each person to estimate an anticipated completion date (ACD) for each project. The anticipated completion date is the author's estimate of the date when the project will be finished; additional time should be allowed for publication of the report. **If you wish more information on a project described herein, please write directly to the author; most of these projects will not be published by the Pennsylvania Geological Survey inasmuch as most are not Survey sponsored projects.**

The listings are grouped into major categories of research to facilitate your search for information on a particular subject. Reports published are listed alphabetically by author. As with all compilations, there may be omissions; this is unintentional.

Additional copies of this report may be obtained by writing to the Bureau of Topographic and Geologic Survey, Department of Environmental Resources, P.O. Box 2357, Harrisburg, Pennsylvania 17120.

AREAL GEOLOGY

150TH ANNIVERSARY
1836 - 1986

JAMES ALCOCK, M. E. WAGNER, and S. P. PHIPPS, Univ. of Pa. **Geology, Metamorphism and Structure of the Area Between Avondale, Pa. and Newark, Del.** ACD: 1987.

R. J. ALTAMURA, Conn. Geol. and Natural History Survey. **Radargeologic Interpretation Map of the Everett, Pa. Quad., Scale 1:62,500.** An independent project utilizing the new side-looking airborne radar (SLAR) imagery acquired from the U.S. Geol. Survey; performed under the supervision of Dr. J. Gardner of MARS Associates, Inc. SLAR strip data and quadrangle mosaic and aerial photography were studied and interpreted in order to map rock types and structure. Several previously unrecognized subunits or facies changes within Devonian-aged rocks of the southwestern and southeastern parts of the quadrangle were interpreted, and previously mapped geology was confirmed.

FROELICH, A. J., Project Chief, U.S. Geol. Survey. **Early Mesozoic Evolution of the Eastern United States.** Conversion of analog aeromagnetic data to digital data was completed for the Gettysburg, Culpeper, Newark, and Hartford basins, and truck magnetometer surveys were completed in the Hartford, Newark, Culpeper, Richmond, Taylorsville, and Durham basins during FY 1985. Field geologic mapping in the Newark basin will continue. Stratigraphic and sedimentologic data in all exposed early Mesozoic basins will continue to be gathered in order to complete a coherent regional stratigraphic synthesis. ACD: FY 1987.

J. D. INNERS, Pa. Geol. Survey. **Geology and Mineral Resources of the Hazleton Quad., Luzerne, Carbon, and Schuylkill Cos., Pa.**

CONST. KARYTSAS and ALAN DAVIS, Pa. State Univ. **The Influence on Coal Character of Climatic Variation During the Upper Pennsylvanian** [western Pa.]. ACD: Dec. 1987.

T. J. KUNTZ and N. K. FLINT, Univ. of Pittsburgh. **Regional Study of Vanport Limestone in Elk County, Pa.** ACD: Aug. 1986.

H. W. SCHASSE, Wash. Geol. Survey, and D. B. MacLACHLAN and J. D. INNERS, Pa. Geol. Survey. **Geology and Mineral Resources of the Conyngham Quad., Luzerne and Schuylkill Cos., Pa.** ACD: Dec. 1986.

J. H. WAY, Pa. Geol. Survey, and R. P. NICKELSEN, Bucknell Univ. **Geology and Mineral Resources of the Lewisburg Quad., Union Co., Pa.** Project scope includes geologic mapping of bedrock and surficial deposits, identifying materials with possible economic potential, and evaluating environmental and engineering characteristics of all geologic units in the area. ACD: 1987.

ECONOMIC GEOLOGY

S. W. BERKHEISER, JR., Pa. Geol. Survey. **Preliminary Analyses of Potential Uses of Select Clay-Shale Resources in Pennsylvania.** About 20 clay and shale samples from various underclays, residual clays, and other sources have been submitted to the U.S. Bureau of Mines for preliminary testing. Physical properties and slow-firing tests are anticipated. ACD: Ongoing.

S. W. BERKHEISER, JR., and R. C. SMITH, II, Pa. Geol. Survey. **Additional Occurrences of Specialty-Use Silica in Pennsylvania.** As a follow-up study to the 1985 high-purity silica study, this investigation identifies and characterizes Cambrian-age clastic resources within the South Mountain area of Adams, Cumberland, and Franklin Counties. Additional data concerning the thickness and quality of selected quartz veins and a few other sandstones are also anticipated. ACD: Dec. 1986.

S. W. BERKHEISER, JR., and R. C. SMITH, II, Pa. Geol. Survey, and J. CULLEN-LOLLIS, Univ. of Cincinnati. **Description and Economic Geology of the Union Furnace Section, Pa. Route 453** [Huntingdon Co.]. Field description, chemical analyses, and environments of deposition will be presented for the Loysburg through Nealmont Formations in the Guidebook of the 51st Annual Field Conference of Pennsylvania Geologists. Clay mineralogy and stratigraphic position of about 20 "bentonitic zones" occurring in the Snyder through Coburn Formations will also be presented. ACD: Oct. 1986.

A. D. GLOVER, C. H. DODGE, J. G. PHILLIPS, J. R. SHAULIS, and V. W. SKEMA, Pa. Geol. Survey. **Coal Resource Maps for All Bituminous-Coal-Bearing Counties, Main Bituminous Field, Western Pa.** This study is an updated coal-resource evaluation for this coal field. The maps include crop lines for each of the principal coal seams, areas of deep and strip mining, and structure contours on a particular coal. Maps for Greene, Allegheny, Butler, and Fayette Counties have been published. Maps for Clarion and Washington Counties are in press, and maps for Cambria, Blair, and Westmoreland Counties are in review. ACD: 1990.

J. A. HARPER, Pa. Geol. Survey. **Iterative Tectonics and Development of Oil and Gas Fields in Pennsylvania.** This project details the relationships between repeated tectonic movement, both basement-related and detached, to the presence of oil and gas reservoirs through effects on sedimentation, fluid migration, and diagenesis. ACD: Summer 1986.

C. D. LAUGHREY, Pa. Geol. Survey, and R. M. HARPER, Pa. Dept. of Environ. Resources, Bur. of Oil and Gas Management. **Oil and Gas Reservoir Rocks of Pennsylvania.** Final report will include detailed petrologic descriptions and interpretations of all of Pennsylvania's major petroleum reservoir rocks along with petrophysical test results and geophysical-log characteristics. ACD: Aug. 1987.

L. J. LENTZ, Pa. Geol. Survey. **NCRDS (National Coal Resources Data System), Part 2.** Data are currently being entered for Cambria County, and corrections are being made to the data base for Greene and Washington Counties. This program will result in computer-generated resource maps for western Pennsylvania.

R. C. SMITH, II, and J. H. BARNES, Pa. Geol. Survey. **Geology and Mineralogy of the Reading Prong, Berks, Bucks, Lehigh, and Northampton Cos., Pa.** Project has been largely inactive for 5 years, but CIPW norms have now been calculated for mineralized granitic samples. ACD: 1987.

R. C. SMITH, II, Pa. Geol. Survey, and D. T. HOFF, State Museum of Pa. **Mesozoic Cu Occurrences We Have Known and Loved** [Mesozoic basin of SE Pa.]. Organizing existing composite samples and tabulating data collected over the years to stimulate investigations by others of the precious-metal potential. Including Cornwall-type ore, contact skarn, veinlets in diabase, diabase late differentiates, and red-bed-type occurrences. ACD: Dec. 31, 1986.

R. W. STANTON, Project Chief, U.S. Geol. Survey. **Coal Petrology.** The effect of sedimentary units adjacent to the Upper Kittanning coal bed in Pennsylvania on the quality and extent of original peat facies and how these differences affect washability characteristics will be evaluated. ACD: FY 1989.

R. W. STANTON, Project Chief, U.S. Geol. Survey. **Coal Washability.** Reports on the following topics will be prepared in FY 1986: drilling, sampling, and descriptions from the Lucerne No. 9 mine; estimation of coal-bed washability from facies description of the bed; the effect of petrographic composition of facies on washability behavior of samples from Lucerne No. 9 mine; sedimentation and its effect on the formation of facies found in the Lower Freeport coal bed; and nondestructive testing methods to predict the washability of coal. ACD: FY 1986.

A. M. STERNAGLE, Pa. Dept. of Transportation. **History of the Blair County Charcoal Iron Industry** [emphasis on the Frankstown and Morrisons Cove area]. Study and history of early iron-making practices, with emphasis on the rock units mined and particular problems associated with each. To date field work locating furnace sites and the actual mines has begun. ACD: 1987.

ENGINEERING GEOLOGY

N. N. MOEBS and G. P. SAMES, U.S. Bur. of Mines. **The Character of Five Selected LANDSAT Lineaments in Southwestern Pennsylvania.** Five lineaments were investigated using earth resistivity, very low frequency (VLF), and soil moisture traverses, and correlation with mine roof instability. Preliminary results indicate that the lineaments were a surface phenomenon only. ACD: 1987.

ENVIRONMENTAL GEOLOGY

W. R. ADAMS, JR., and N. K. FLINT, Univ. of Pittsburgh. **Landsliding in Allegheny County, Pa.—Characteristics, Causes, and Cures.** Over 200 slope movements were investigated for this Ph.D. research project. Data from field reconnaissance, published materials, and input from a group of experts were used to develop a model to estimate the potential for slope failure. ACD: Aug. 1986.

R. H. CAMPBELL, Project Chief, U. S. Geol. Survey. **Landslide Probability and Risk Methodologies.** Work will continue in an advisory capacity to the School of Urban and Public Affairs at Carnegie Mellon University to evaluate applications of past research to the Pittsburgh area, and to develop a decision-support system to determine whether developers should be required to make site improvements for the purpose of reducing the risk of damage from earthquakes. ACD: FY 1989.

H. L. DELANO and J. P. WILSHUSEN, Pa. Geol. Survey. **Landslide Susceptibility in the Williamsport 1° x 2° Map Area, Pa.** A map of susceptibility zones and text with discussion of known landslide occurrences related to geological and other factors. ACD: 1986.

OMAR GHOWERI and R. A. VARGO, Calif. Univ. of Pa. **Slope Analysis of the Donora, Pa. Quad.** ACD: Summer 1986.

SUSAN GHOWERI and R. A. VARGO, Calif. Univ. of Pa. **Slope Analysis of the California, Pa. Quad.** ACD: Summer 1986.

W. E. KOCHANOV, Pa. Geol. Survey. **Sinkhole Occurrence in the Carbonate Rocks of Lehigh County.** Completion of 7½-minute quadrangles comprising Lehigh County showing carbonate geology, structural data, sinkholes and related karst features, mines, and quarries. Computer inventory in progress. Will be available as an open-file report. ACD: Spring 1986.

JOEL MORRISON, EUGENE WILLIAMS, ALAN DAVIS, and ARTHUR ROSE, Pa. State Univ. **A Study of Factors Controlling the Occurrence and Severity of Acid Mine Drainage in the Allegheny Group of Western Pennsylvania.** ACD: Aug. 1986.

D. A. MOSCONI and R. R. PARIZEK, Pa. State Univ. **The Evaluation of Chloride Transport in Ground Water Within Zones of Fracture Concentration** [Bear Creek, Pa.]. ACD: Dec. 1986.

F. J. VENTO and P. T. FITZGIBBONS, Vendel Enviro-Industrial Consultants, Inc., and P. V. VENTO, Univ. of Pittsburgh. **Phase I Archaeologic and Geoarchaeologic Investigations at Cowanesque Lake, Tioga Co., Pa.** Present studies involve general site geology and geomorphology, site sedimentation and sediment sources, Holocene paleosol development, soil geochemistry, and petrography of artifactual materials. ACD: May 15, 1986.

GENERAL GEOLOGY

H. L. DELANO, Pa. Geol. Survey. **Guide to Geology of Presque Isle State Park, Pa.** Layman's guide will include origin and history of the peninsula, coastal erosion and deposition processes and features, and history of engineering efforts to limit erosion. ACD: 1986.

J. R. EGGLESTON, Project Chief, U.S. Geol. Survey. **Pennsylvania Anthracite Basin Framework.** A summary report on the age of the youngest rock in the Southern Anthracite field will be prepared in FY 1986. The lateral extent, character, and depositional history of the Mill Creek Limestone in the Northern Anthracite field will be defined, and stratigraphic and structural interpretations in part of the Wyoming basin will be developed. ACD: FY 1989.

C. H. SHULTZ, editor, Slippery Rock Univ. and Pittsburgh Geol. Soc. **The Geology of Pennsylvania.** This book-writing project is being developed and managed by the Pittsburgh Geological Society. The book will be published by the Pennsylvania Geological Survey; it will be of large format and about 600 pages long with 16 pages of color. Coverage is encyclopedic and is organized into 58 chapters grouped into nine parts. It is authored by 73 recognized experts from eight states. Writers are about equally divided among government, industry, and academia. Nearly 80 percent of manuscripts are now in hand, undergoing review and revision. Remaining manuscripts are anticipated by June 1, 1986. ACD: Summer 1988.

GEOCHEMISTRY

MICHAEL BIKERMAN, R. M. FEATHER, JR., MICHAEL HARTLEY, and C. D. McNAUGHTON, Univ. of Pittsburgh. **Uplift Timing in the Appalachians.** K-Ar and fission-track geochronological techniques are to be applied to the determination of uplift ages in the Appalachians and Allegheny Plateau. ACD: 1987–88.

C. B. CECIL, Project Chief, U.S. Geol. Survey. **Geochemical Environments.** Laboratory studies were conducted on the genesis of quartz in the Upper Freeport coal bed in Pennsylvania, and mineralogical analyses were made of selected samples of coal and paleosols. Selected coal-bed samples will be studied in FY 1986 to determine the origin of mineral matter in coal and to evaluate the geochemical conditions of sedimentation. Paleobotanical and paleoecological investigations to establish correlations among coal quality, paleoecology, and coal petrology are also planned. ACD: FY 1988.

P. G. HATCHER, Project Chief, U.S. Geol. Survey. **Metal-Organic Interactions.** Phytoclasts and shales rich in organic matter were collected from the Hartford, Newark, Taylorsville, Richmond, and Sanford basins in FY 1985. X-ray spectroscopy and scanning electron microscopy studies of Newark basin clay minerals and size separates of the clay minerals are planned in FY 1986. ACD: FY 1988.

P. P. HEARN, Project Chief, U.S. Geol. Survey. **Diagenesis of Authigenic K-Feldspar in Lower Paleozoic Carbonate Rocks of the Appalachian Basin.** Preliminary sampling of Cambrian carbonate rocks was conducted in FY 1985 in the Appalachian Valley and Ridge province of Pennsylvania, Maryland, Virginia, Tennessee, and Georgia, and also in western Vermont. Age-spectrum analyses of authigenic overgrowths on grains of detrital K-feldspar indicate that the rocks in the Valley and Ridge province of the central and southern Appalachians experienced a regionally synchronous fluid-migration event associated with the Alleghanian orogeny. During FY 1986, high-precision radiometric, chemical, and isotopic analyses of 10 to 12 purified K-feldspar and quartz separates from feldspathized rocks from the southern, central, and northern Appalachians and the mid-continent area will be completed. The utility of authigenic K-feldspar in dating fluid-migration events and characterizing the chemical evolution of fluids in sedimentary basins will be evaluated. ACD: FY 1986.

J. M. McNEAL, Project Chief, U.S. Geol. Survey. **Sulfur Isotopes in Triassic Basins.** The results of sulfur-isotopic and chemical analysis of water and rock samples collected in FY 1985 from the York Haven, Zora Ring, and the Newark basin in Pennsylvania will be evaluated in FY 1986. If time permits, NURE stream-sediment and water chemistry data for the Mesozoic basins will be completed and evaluated. Plans for sulfur-isotopic examination of the diabase in all of the Mesozoic basins and groundwater geochemistry studies in areas of specific interest, including those indicated by the examination of the NURE data, will be developed. ACD: FY 1988.

A. W. ROSE and ADAM HUTTER, Pa. State Univ. **Geological and Geochemical/Mineralogical Controls of Radon Concentration in Soil Air** [Pa. and surrounding regions]. ACD: Fall 1986.

NED TILLMAN, Target Exploration, Inc. **Use of Surface Geochemical Surveys for Delineating Natural Gas Reservoirs** [Somerset, Westmoreland, Fayette, Cambria, Clearfield, Centre, Tioga, and McKean Cos.]. Successfully used a carefully selected suite of surface geochemical tools to explore for, discover, and help develop gas reservoirs. ACD: Ongoing.

GEOMORPHOLOGY

D. D. BRAUN, Bloomsburg Univ. **Large Scale Mass Movement on Shickshinny Mountain** [NE Pa.]. Mapping of mass movement distribution and determination of mode and origin of slope failure. ACD: 1988.

C. R. LEMIEUX and T. W. GARDNER, Pa. State Univ. **Infiltration and Runoff on Strip Mine Soils** [Moshannon, Pa.]. Investigation of mine soil infiltration response to rainfall intensity, antecedent moisture, and soil age. Results to be applied to a watershed runoff model (ANSWERS) and evaluated by comparison of actual runoff data and model predictions. ACD: Dec. 1986.

I. D. SASOWSKY and W. B. WHITE, Pa. State Univ. **Longitudinal Stream Profiles and the Evolution of Karst Drainage Basins in the Appalachian Orogenic Belt** [includes part of Elk Creek drainage basin, Centre Co.]. Eight drainage basins between Pennsylvania and Tennessee are being studied to evaluate the use of longitudinal stream profiles in interpreting geomorphic evolution in karst terranes. ACD: Aug. 1986.

W. D. SEVON, Pa. Geol. Survey. **Pennsylvania Landscape Evolution.** Continuing investigation of age and process of development of the present landscape of Pennsylvania.

GEOPHYSICS

J. D. PHILLIPS, Project Chief, U.S. Geol. Survey. **Geophysical Mapping of Early Mesozoic Basins.** Aeromagnetic maps and interpretive cross sections for the North Hartford, Gettysburg, Newark, and Culpeper basins and gravity maps for the Culpeper, Gettysburg, Farmville, and Richmond basins will be completed in FY 1986. Gravity data will be collected in the Hartford, Newark, and Wadesboro basins. Reports on truck magnetometer data collected in the Newark, Culpeper, and Richmond basins are being prepared, along with a report on diabase intrusions in the Durham basin using truck magnetometer and gravity data. Landsat TM images will be used to define structures and lithology between the Newark and Gettysburg basins. ACD: FY 1987.

N. M. RATCLIFFE, Project Chief, U.S. Geol. Survey. **Northeastern United States Seismicity and Tectonics.** Three VIBROSEIS reflection profiles of the western margin of the Newark basin and contiguous rocks of the Reading Prong in New Jersey and Pennsylvania reveal that dips of the Mesozoic border faults decrease from 50 degrees in central New Jersey to 30 degrees in Pennsylvania near the Delaware River. These dips are confirmed by continuous core of the border faults on each of the lines. Gentle to moderately dipping reflections beneath or within basement rocks west of the Newark basin are subparallel to faults at the basin margin. At Riegelsville, Pennsylvania, VIBROSEIS data, coring, and surface mapping indicate that the shallow 30-degree dip of the Mesozoic border fault was formed by reactivation of imbricate thrust faults of the Musconetcong thrust system. Plans for FY 1986 include completing the interpretation of VIBROSEIS data collected across the Newark basin and the preparation of reports for publication. ACD: FY 1986.

GLACIAL GEOLOGY

D. D. BRAUN, Bloomsburg Univ., and W. BRENNAN, SUNY, Coll. at Geneseo. **Development of a Secular Geomagnetic Record for Use in Correlating Ice Margin Positions Across the Allegheny Plateau in North Central Pennsylvania.** Proglacial lake rhythmites will be sampled in conjunction with mapping of glacial deposits in selected valleys. Geomagnetic declination values will be examined to see if groupings of similar values can be traced across the Plateau. ACD: 1988.

D. D. BRAUN, Bloomsburg Univ., and J. D. INNERS, Pa. Geol. Survey. **Extent of Pre-Wisconsinan Glaciation in the Anthracite Region of Pennsylvania.** Mapping of glacial deposits and buried valley segments is being undertaken to the southwest of the Wisconsinan glacial limit between the North Branch Susquehanna River and the Lehigh River. ACD: 1989.

G. H. CROWL, Ohio Wesleyan Univ. **Map of the Illinoian Glacial Border in Pennsylvania.** ACD: June 1986.

W. D. SEVON, Pa. Geol. Survey. **Mapping of Surficial Geology North of the Late Wisconsinan Glacial Limit, Northeastern Pa.** Project includes 148 7½-minute quadrangles in northeastern Pennsylvania. Mapping is being done at 1:24,000 scale, and will be supplemented by laboratory analysis of till and sand and gravel. Field work 49 percent completed; 18 percent of maps prepared. ACD: 1989.

W. D. SEVON, Pa. Geol. Survey. **Surficial Geology of Glaciated Valleys, Bradford, Potter, and Tioga Cos.** Mapping of surficial deposits in glaciated valleys for groundwater evaluation project. Map compilation at 1:100,000 scale. ACD: July 1, 1986.

HYDROLOGY

G. M. BANWELL and R. R. PARIZEK, Pa. State Univ. **Helium-4 and Radon-222 Concentrations in Groundwater and Soil Gas as Indicators of the Extent and Depth of Fracture Concentration in Rock** [Lehigh Co.]. The concentration of helium-4 in groundwater from domestic wells appears to increase near lineaments in the Martinsburg Formation in Lehigh County. Groundwater radon-222 activities may decrease near lineaments, but less consistently than helium-4 increases. ACD: May 1986.

R. J. BIERY and ANTHONY VENTELLO, Bradford Co. Planning Comm., and MICHAEL HUFNAGLE, Mansfield Univ. **Ground Water Resources Guide, Bradford Co., Pa.** Existing and original data will be compiled into a representative report for Bradford County. The data will delineate present and future groundwater resources and locate possible land use threats to these valuable resources. ACD: Fall 1987.

MARY HRENDA and R. R. PARIZEK, Pa. State Univ. **The Groundwater Flow System of a Small Drainage Basin on Laurel Hill in Southwestern Pennsylvania, with Special Emphasis on the Neutralization of Acidic Precipitation.** ACD: Dec. 1986.

T. A. McELROY, Pa. Geol. Survey. **Groundwater Resources of Cambria Co., Pa.** ACD: In review.

T. A. McELROY, Pa. Geol. Survey, and D. R. WILLIAMS and J. K. FELBINGER, U.S. Geol. Survey. **Geology and Water Resources of Indiana Co., Pa.** Purpose is to evaluate the surface water and groundwater conditions throughout Indiana County and to determine the effect of coal mining and gas wells on the resources. A geologic map will be included. ACD: 1989.

D. R. WILLIAMS, J. K. FELBINGER, and P. J. SQUILLACE, U.S. Geol. Survey. **Hydrogeology, Water Resources, and the Hydrologic Effects of Coal Mining, Washington Co., Pa.** Data collection phase of the project was completed as of Sept. 30, 1985, and the first draft copy of the report will be completed by May 31, 1986. The report will be of interest to anyone concerned about the water resources of Washington County, in particular the groundwater resources. ACD: Sept. 30, 1986.

IGNEOUS AND METAMORPHIC PETROLOGY

A. L. HOERSCH, LaSalle Univ., and W. A. CRAWFORD, Bryn Mawr Coll. **Metamorphic and Deformational History of the Mine Ridge**

and Honey Brook Upland, Pa. We are developing a model to explain the structural evolution and petrogenesis of the Mine Ridge, Honey Brook Upland, and surrounding Cambro-Ordovician metasediments. In addition we plan to evaluate and correlate models of the evolution of the Pennsylvania, Delaware, and Maryland Piedmonts and the Reading Prong using this data and data of other workers in the area. ACD: 1989.

M. E. WAGNER and LeeANN SROGI, Univ. of Pa. **Taconic Metamorphism at Two Crustal Levels and a Tectonic Model for the Pennsylvania-Delaware Piedmont.** It is suggested that during the Taconic orogeny Grenville crust of the West Chester prong was carried down an east-dipping subduction zone beneath the hot infrastructure of a volcanic arc—now the granulite-facies gneisses and plutonic igneous rocks of the Wilmington Complex. ACD: 1986.

C. D. WITANACHCHI, Bryn Mawr Coll. **Metamorphism and Deformation in the Wissahickon Schist near Bryn Mawr, Pa.** ACD: May 1986.

MINERALOGY

E. G. CHARLES and J. L. HUGHES, Miami Univ. (Ohio). **Unusual Reduction Spot Mineralogy (Hamburg Sequence), Shartlesville, Pa.** Preliminary EDAX and XRD work indicates that an unusual mineralogy exists in small (<1 mm) two-phase centers in the middle of reduction spots of red shales at Shartlesville. ACD: June 1987.

PALEONTOLOGY

PETER BRETSKY, SUNY, Coll. at Stony Brook. **Morphological Variation in the Middle Devonian Bivalve Mollusk *Eodon bellastriatus* (Conrad)** [Newport/Amity Hall/Girtys Notch]. The distribution of morphological variation within and among stratigraphically contiguous populations of *Eodon bellastriatus* over a 4-m interval of Mahantango mudstones (mid-Devonian) in central Pennsylvania is being examined. The shallow infaunal *E. bellastriatus* colonized muds near the initiation of three coarsening-upward cycles. Colonization was followed rapidly by influx of large numbers, and then decline as the physical regime changed. ACD: Dec. 1986.

S. S. FONDA and R. J. CUFFEY, Pa. State Univ. **Late Pleistocene Vertebrates from a Filled Fissure in Central Pennsylvania.** A Late Pleistocene fauna of 48 species (now extinct) has been recovered. ACD: Nov. 1986.

W. F. KLOSE II, Paleontological Research Inst. **Fossil Floras of the Bernice Basin, Sullivan Co., Pa.** A study of the fossil floras associated with the post-Pottsville sediments in the Bernice coal basin with correlation between the anthracite coal basins to the east and the bituminous coal fields to the west. ACD: 1990.

W. F. KLOSE II, Paleontological Research Inst. **Fossils of the Anthracite and Semi-Anthracite Coal Fields of Northeastern Pennsylvania.** A revision to the succession of fossil floras and faunas of the anthracite and semi-anthracite coal fields of northeastern Pennsylvania. A monograph and collector's handbook is planned, illustrating the fine specimens in major U.S. museums. ACD: 1995.

W. A. OLIVER, JR., U.S. Geol. Survey. **Corals and Biostratigraphy of the Keyser and Helderberg Limestones and Equivalents in the Appalachian Basin** [N. Y., N. J., Pa., Md., W. Va., Va.]. Rugose corals are being described, and their stratigraphic and areal distribution analyzed from the fine-grained, stromatoporoidal facies of Pridolian-Lochkovian age. ACD: 1986–87.

J. F. TAYLOR, R. W. TRAUT, and P. J. FEDERINKO, Ind. Univ. of Pa. **Trilobite Biostratigraphy of the Stonehenge and Grove Formations in Pennsylvania, Maryland, and Northern Virginia.** Lower Ordovician trilobite biozones are being used to compare the ages of the Stonehenge Formation in the Nittany Arch, the Stonehenge Formation in the Great Valley, and the Grove Limestone in the Frederick Valley of Maryland. ACD: 1987.

ALFRED TRAVERSE, Pa. State Univ., N. G. JOHNSON, Univ. of N. C. at Chapel Hill, and P. K. STROTHER, Boston Univ. **Evidences of Earliest Land Plants in Latest Ordovician and Early Silurian Rocks** [central Pa.]. ACD: Ongoing.

SEDIMENTOLOGY

D. E. COSTOLNICK, SUNY, Coll. at Oneonta. **Sedimentology of the Mississippian-Devonian Spechty Kopf Formation in Northeastern Pennsylvania** [east flank of Lackawanna syncline at intersection of Rtes. 380 and 435]. A detailed lithologic description of the Spechty Kopf along Roaring Brook and Rte. 380 including photos and descriptions of a wide range of sedimentary structures interpreted as representing a slope deposit along the margin of a lake or restricted basin. ACD: June 1986.

EDWARD COTTER, Bucknell Univ. **Medial Silurian Depositional History—Central Pennsylvania.** ACD: 1987.

J. A. DIEMER and PERRI PHILLIPS, Franklin and Marshall Coll. **Sedimentology of Fluvial and Coastal Facies, Upper Devonian of Southcentral Pennsylvania.**

A. L. GUBER, Pa. State Univ. **Facies Analysis of the Middle and Upper Silurian Formations of Central and Western Pennsylvania.** A geochemical, paleontological, and sedimentological approach to facies definition and analysis of the Mifflintown, Wills Creek, and Tonoloway Formations. ACD: Ongoing.

G. L. LASH, SUNY, Coll. at Fredonia. **Depositional Processes of the Martinsburg Formation of Eastern Pennsylvania.** Preliminary results suggest that the lower two-thirds of the Martinsburg Formation (Bushkill and Ramseyburg Members) was deposited as part of a prograding deep-sea clastic system whereas the upper member (Pen Argyl Member) accumulated in a morphologically restricted basin from confined turbidity currents. ACD: Fall 1987.

C. D. LAUGHREY, Pa. Geol. Survey. **Significance of Ooids in the Speechley Sand (Upper Devonian Bradford Group) of Western Pennsylvania.** ACD: Spring 1986.

S. T. PEES, Samuel T. Pees and Assoc. **The Queenston Formation Erosional Surface in Portions of Northwestern Pennsylvania and Adjacent Areas** [NW Pa., SW N. Y., NE Ohio]. Well log and core study of the Queenston Formation-Medina Group contact to determine relief, surface conditions, and rock competency at the unconformity (or disconformity). ACD: Feb. 1987.

C. D. LAUGHREY and J. A. HARPER, Pa. Geol. Survey. **Geology of Lower Venango Group (Late Devonian) Rocks in Southwestern Pennsylvania.** The stratigraphy and depositional history of Venango Group rocks exposed at Victoria, Fayette County, will be studied and related to reservoir potential in the oil and gas fields of Greene, Washington, and Allegheny Counties. ACD: Summer 1986.

E. L. SIMPSON, Va. Polytechnic Inst. and State Univ., BRUCE ROWELL, Kutztown Univ., and CHARLES HARRIS and KENNETH ERIKSSON, Va. Polytechnic Inst. and State Univ. **Alluvial to Tidal Shelf Transition Within the Lower Cambrian Hardyston Formation of Eastern Pennsylvania.** Our study has characterized facies and facies associations within the Hardyston Formation. Based on these subdivisions, we have interpreted the types of processes that occurred with both alluvial and tidal environments. ACD: Dec. 1986.

RUDY SLINGERLAND and J. P. LOULE, Pa. State Univ. **Sediment Dispersal Processes on the Upper Devonian Catskill Shelf in Northcentral Pennsylvania** [Tioga, Bradford, Lycoming, and Clinton Cos.]. The authors will attempt to determine the mechanisms of emplacement of sublittoral sands in the Lock Haven Formation by characterizing their facies sequences and architecture in selected stratigraphic sections. ACD: Dec. 1988.

SUZANNE WEEDMAN and A. L. GUBER, Pa. State Univ. **Facies Analysis and Petrology of the Upper Freeport Limestone** [Armstrong and Indiana Cos.]. Of special interest in this study are the role carbonate lakes played in the drainage network of the late Allegheny alluvial-deltaic plain and the paleoclimatic implications of floodplain carbonate sedimentation. ACD: 1987.

STRATIGRAPHY

RICK BORKOWSKI, Pa. State Univ./Sun E & P Co. **Depositional and Reservoir Characteristics of the Lower Devonian Oriskany Sandstone** [Appalachian basin]. The Oriskany Sandstone "complex" represents storm-dominated sedimentation within a prograding clastic sequence resulting from progressive erosion of Lower Devonian and Silurian units (down to at least the Tuscarora) to the east. Influx of shield sediments is indicated by the occurrence of fine-grained arkosic sandstones interbedded with coarser calcareous sandstones and orthoquartzites in the western interior portion of the basin. The uppermost Oriskany is interpreted as being reworked during the final stages of transgression (Wallbridge discontinuity). ACD: 1986–87.

A. D. GLOVER, C. H. DODGE, J. G. PHILLIPS, J. R. SHAULIS, and V. W. SKEMA, Pa. Geol. Survey. **TASIC (Temporarily Available Stratigraphic Information Collection)** [north-central and western Pa.]. This is a continuing program to collect stratigraphic data and coal samples for analysis in active coal and clay mines. The project will provide data for future mapping and regional resource evaluation. ACD: Ongoing.

J. A. HARPER, Pa. Geol. Survey. **Late Devonian Transgressive-Regressive Cycles in Pennsylvania** [western Pa.]. Will be a short, generalized discussion of transgressive-regressive cycles seen in Late Devonian reservoir rocks (the Venango Group) of western Pennsylvania, with speculation on mechanisms and durations. ACD: Summer 1986.

A. G. HARRIS, Project Chief, U.S. Geol. Survey. **Conodont-Based Ages in the Appalachian Orogen.** Field work will continue in Pennsylvania and New York and will include collecting and measuring Upper Silurian-Lower Devonian sections. ACD: FY 1985.

T. W. HENRY, Project Chief, U.S. Geol. Survey. **Appalachian Basin Biostratigraphic and Depositional Framework.** A study to trace the extinction of lycopods in the basal part of the Conemaugh Formation together with clarifying where coal beds of the Lower Pennsylvanian of Ohio correlate with those of the proposed Pennsylvanian System stratotype. The Sciotoville Clay Member of Ohio, considered by general consensus to be Lower Pennsylvanian, needs to be examined for palynomorphs; a limited amount of field work will be undertaken in western Pennsylvania, eastern Ohio, and northeastern Kentucky. ACD: FY 1988.

S. T. PEES, Samuel T. Pees and Assoc. **Distribution of Lumped Net Effective Sand in the Grimsby and Cabot Head Formations, N.W. Pennsylvania, N.E. Ohio** [Crawford Co. and portions of adjacent Erie, Warren, Venango, and Mercer Cos., Pa., and eastern strip of Ashtabula Co., Ohio]. Seventy percent clean sand in the multiple sandstone bodies is isopached as a "unit" over 2,629 mi^2 using 1,915 well logs for the purpose of determining build-up trends of total sand. ACD: May 1986.

R. C. SMITH, II, and J. H. WAY, Pa. Geol. Survey. **Tioga Ash Zone in the Valley and Ridge of Pennsylvania.** Ten relatively complete and five partial sections of the Tioga Ash Zone have been measured, described, and sampled. At least seven beds are recognizable, several with distinctive characteristics. Precise correlations across the province are possible. The Onondaga-Marcellus contact is time transgressive. ACD: 1986.

STRUCTURAL GEOLOGY

WAYNE BREWER, PAUL HUDAK, and JIM HOLL, Allegheny Coll. **Strain and Subsurface Structure of the Homoclinal Appalachian Plateau in Northwestern Pennsylvania.** ACD: Open.

ROBERT De GRANDIS and THOMAS ANDERSON, Univ. of Pittsburgh. **Subsurface Geology Across a Segment of the Pittsburgh/Washington Lineament.** ACD: June 1987.

GRETCHEN GILLIS and L. B. PLATT, Bryn Mawr Coll. **Rock Strain at Chickies Rock.** The strain, mostly pressure dissolution and formation of subgrains, in quartzite at Chickies Rock is being evaluated, following D. U. Wise (1960), who determined bulk strain there by measuring orientation and ellipticity of *Scolithus* tubes. ACD: May 1986.

J. M. HULL, Rutgers Univ., Newark. **Displacement Transfer Along the Chalfont Fault** [SE Pa.]. Extended the structural analysis east to the Hopewell fault. ACD: June 1987.

G. G. LASH, SUNY, Coll. at Fredonia. **Progressive Development of Scaly Cleavage in Rocks of the Greenwich Slice, Hamburg Klippe (Eastern Pa.).** Scaly cleavage in deformed zones of the Greenwich slice will be studied using optical petrographic and SEM methods. ACD: Fall 1988.

J. C. PALMQUIST, Lawrence Univ., and S. T. PEES, Samuel T. Pees and Assoc. **Vector Analysis of Linear Features in the Townville 7.5′ Quadrangle, Crawford Co., Pa.** Computer analysis of the frequency of fracture traces by group, azimuth, and length categories. The linear features were interpreted by remote sensing. ACD: Sept. 1986.

JONATHON PERREGO and RICHARD LOWRIGHT, Susquehanna Univ. **A Study of the Cause of Apparent Offset in Trend at Shamokin Mountain and Montour Ridge in the Vicinity of Lewisburg, Pa.** ACD: May 1986.

V. J. PFAFF, Univ. of Cincinnati. **Forms of Small Folds in the Central Appalachians, Pa.** [along the Juniata River in Perry Co.]. ACD: Aug. 1986.

S. I. ROOT, Coll. of Wooster. **Structure and Hydrocarbon Potential of the Gettysburg Basin, Pa. and Md.** Basin is geochemically overmature and source rocks are lean. Small folds are high-risk structural traps. ACD: 1986.

DAVE WILTSCHKO and R. C. FLETCHER, Texas A & M Univ. **The Mechanics of Contrasting Structural Styles in Fold/Thrust Belts** [Plateau and Valley and Ridge; transect from Pittsburgh toward Philadelphia]. A mechanical investigation into the conditions and controlling parameters of folding as opposed to thrust faulting. We wish to understand why folds rather than thrust faults develop in foreland fold/thrust belts, and vice versa. ACD: Dec. 1988.

C. G. WISWALL, West Chester Univ. **Structural Analysis of a Section Along the Brandywine Creek, Southeastern Pa. and Northern Del.** ACD: 1988.

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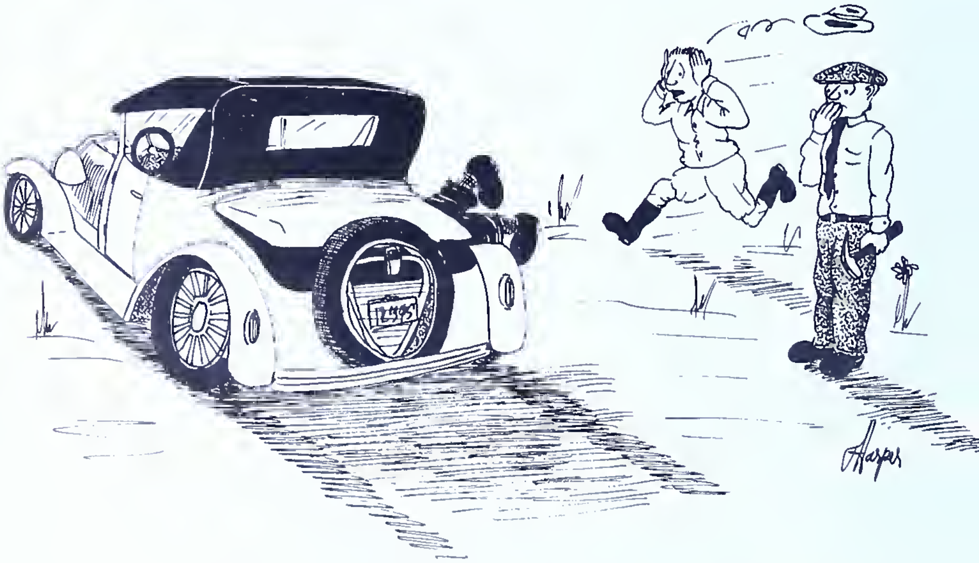
Geochips

Here's one from Mike Shaffner's archives:

I remember one hot summer day. . .we were out in the field wit Dr. Ashley.* Late Twenties, I think it was. We were driving one o those old roadsters. Pete Foose was along on that trip. Well, whe we got to where we were going, something happened to Ashley' camera. What happened was—the film got stuck and wouldn't mov ahead. He got out, went around back of the car and lifted up the trun lid. He said, "I can just crawl in here and use this for a darkroo and fix the film." Ashley said to us, "You boys go ahead and do wha you want to do here. . . ." Well—Pete and I were gone for half a hour or more, I guess. Now, when we got back, all we could see wer Ashley's legs stickin' out from the trunk! I guess the lid had gotte stuck somehow. You know—we just got him out in time! He was huf fin' and puffin'—just about to breathe his last breath. Oh my! Tha sure coulda' been disasterous!

*George Ashley was State Geologist of the Fourth Pennsylvania Geological Surve from its beginning in 1919 until he retired in 1947. Mike Shaffner worked as a Geologis for the Survey from 1922 until his retirement in 1962.



GEM AND MINERAL SHOW

The Mineralogical Society of Pennsylvania will hold its 21st Annua "Earth Treasures" Gem and Mineral Show at the South Lancaste County Fairgrounds, Quarryville, PA, on Route 472 just south of 372 Show dates are October 18 & 19, 1986, Saturday - 10 a.m. to 6 p.m and Sunday - 10 a.m. to 5 p.m. There will be a variety of Minerals gems, fossils, and jewelry displayed. Entrance will be by a $2.0 donation.

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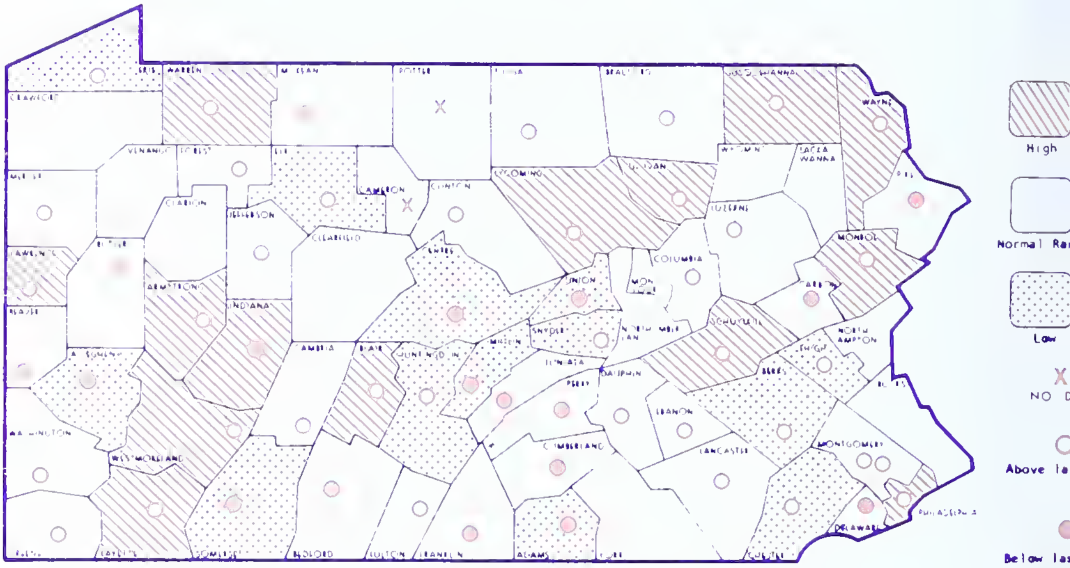

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PYG 345.17/4
Vol. 17, No. 5
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PENNSYLVANIA
GEOLOGY

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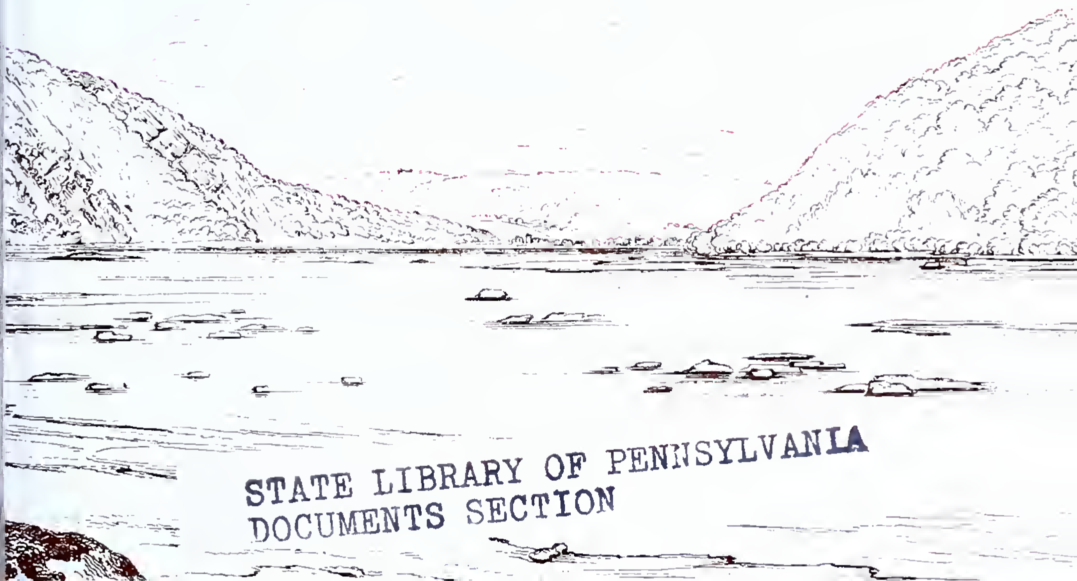

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TOPOGRAPHIC AND GEOLOGIC SURVEY

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ON THE COVER: Reproduction of a portion of a copper plate lithograph entitled "Second Mountain Gap, Susquehanna River", sketched by George Lehman, an artist employed by Henry D. Rogers in the 1840's to illustrate *The Geology of Pennsylvania, a Government Survey*, published in Philadelphia, Pa. in 1858.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania 17120.

Editor, Donald M. Hoskins.

Articles may be reprinted from this magazine if credit is given to the Topographic and Geologic Survey.

VOL. 17, No. 5 **OCTOBER 1986**

Harvest of the Season

With Fall comes the celebration of the harvest of our labors and a sharing of our efforts. For our Bureau, Fall is both a beginning and an ending. A beginning of more intensive field work in our ongoing mapping projects as the falling foliage reveals rock outcrops hidden by summer's greenery - and an ending as some of our work becomes available to the public. Thus, in this issue of "Pennsylvania Geology" we announce the publication of the free report on the geology of the Department of Environmental Resources' Kings Gap Educational Center.

And with 1986's Fall, the column you are reading is different from the one to which you are accustomed. The past Director of the Pennsylvania Geological Survey, and former writer of this page, has ended his formal efforts on behalf of the citizens of Pennsylvania. The Geologic Survey of Pennsylvania, however, has had a long and productive history in public service and we shall strive to continue this service and share with you our continuing "harvest" through this column and publication.

As part of our harvest, in this issue we share with you the results of our cooperative association with the U.S. Geological Survey's National Mapping Division in announcing new 1:100,000 topographic maps and a new distribution site for map purchase. We announce for your use aerial photography added to our library's collection. We notify you of the efforts of our Environmental Geology Division, in cooperation with the U.S.G.S.'s Water Resource Division, in improving the methods of maintaining and searching our extensive files of water well data. And we report to you a mineral found only at four sites in the world, one of which is in Pennsylvania. Finally, we share with you the report of one of our friends in the geologic community who writes of new fossils to be found in Lancaster County.

It is our Bureau's pledge to continue to "harvest" the products of our staff, colleagues and friends so we can share them with you during all seasons as we have in the past.

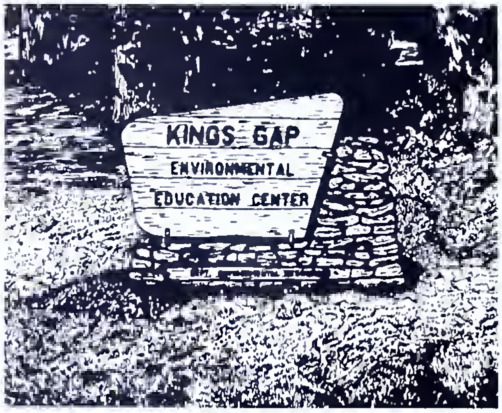
Guide to the Geology of Kings Gap Published

The Bureau of Topographic and Geologic Survey has published a booklet entitled, *Your Guide to the Geology of the Kings Gap Area, Cumberland County, Pennsylvania.* Prepared as a joint project with the Bureau of State Parks this free booklet gives a broad overview of the geology of the South Mountain region, around the Kings Gap Environmental Education and Training Center, which is located approximately 25 miles southwest of Harrisburg, Pennsylvania.

This report is one of the many reports issued by the Department of Environmental Resources as part of its program of Environmental Education, and is aimed at aiding the understanding of visitors to the Education Center into the multifaceted origin of the mountains, and their included rocks and mineral resources. A major portion of the text is devoted to the economic development of the area's natural resources which can be traced back to colonial times. A location map with 20 sites described in the text is included. Highlighted is the view of Pennsylvania's Great Valley and Blue Mountain from the Mansion Terrace atop South Mountain, the 18th Century iron industry and iron mining, and prominent rock outcrops and minerals found locally.

The 31-page booklet is profusely illustrated with drawings and maps. It is written in layman's language and is distributed free to the public.

A copy of *Your Guide to the Geology of the Kings Gap Area, Cumberland County, Pennsylvania,* Environmental Geology Report No. 8, is available from the Kings Gap Environmental Education and Training Center, 500 Kings Gap Rd., Carlisle, Pa. 17013, or from the Pennsylvania Geological Survey, P.O. Box 2357, Harrisburg, Pa. 17120.



WATER WELL INVENTORY -- A STATUS REPORT

Donna M. Snyder
Pennsylvania Geological Survey

In the October 1983 issue of "Pennsylvania Geology," we reported on the history, current status and future projections concerning our Water Well Inventory Program. Since that time, we have instituted a major change in our computer processing. A new data base has been developed to replace our outdated system. The Water Well Computer Data file established in 1969 only allowed for sorting by county and township. The new data base allows for various types of sorting and selecting of records and can produce customized reports according to individual user needs.

In a cooperative effort with the U.S. Geological Survey (USGS), we have developed a new data base for the Pennsylvania Water Well Inventory Program. The new data base uses the USGS Prime Computer in Harrisburg. Computer terminals are now installed in the Pennsylvania Geological Survey's office in Harrisburg from which we directly access the files for data entry and retrieval. We are now in the process of adding data to the file. To date, we have entered approximately 18,000 well records. Table 1 lists those counties which have been completed. The total number of well records for each county represents two types: 1) those wells that have had a map location determined in the office and then coded with information based on the map location and 2) those wells for which no map location could be determined and thus no processing completed other than computer entry of driller provided data.

Each well record in the new data base is assigned an identification number. Reports generated from the new data base will include wells with numbers ending with an 'N' which represents a well for which a map location has been determined. A well number preceded with a 'UL' indicates that that well was not located or processed other than computer entry of the information provided by the driller. The Pennsylvania Water Well Inventory file is classified as *unverified* data in that the well location or other data has not been verified at the well site. (For detailed groundwater studies, which contain field-location and *verified data* on selected water wells,

Table 1. Counties Completed - Computer Entered Into Water Well Inventory Data Base

County	Year of Update	Number Of Well Records Entered
Adams	7-83	997
Allegheny	8-83	192
Armstrong	7-83	262
Bucks	12-84	2853
Cameron	8-86	34
Carbon	7-84	1184
Centre	7-86	258
Clearfield	6-86	226
Clinton	8-86	257
Columbia	6-86	213
Delaware	12-84	349
Elk	10-85	102
Erie	10-85	927
Fayette	8-86	81
Franklin	8-85	1649
Juniata	7-86	155
Lancaster	7-86	4973
Lebanon	7-86	917
Lycoming	8-86	675
Mifflin	8-86	132
Northumberland	7-86	179
Perry	6-84	394
Potter	8-86	291
Snyder	8-86	291
Sullivan	8-86	116

please consult our List of Publications for the appropriate report covering your area of interest.) In cooperation with the USGS, we are also establishing procedures for providing information from the USGS *verified* Ground-Water Site Inventory file (GWSI) to all users of groundwater data. GWSI will be discussed in a future article in 'Pennsylvania Geology'.

We currently have a backlog of 30,000+ well records to enter in the new system and plan to greatly reduce this backlog over the next six or seven months so that information is available for each county.

The original four-part computer printouts (records from 1966-1979) will still be available along with the new printouts (records from 1980-present). In instituting the changes in computer processing, we feel we are able to provide a more efficient data retrieval system.

Table 2. Water Well Inventory Data and Service Fees

PRINTOUTS

Under 10 sheets	No charge
10 sheets or more (including first 10 sheets)	.02 per sheet

XEROXING OF MAPS AND RECORDS

Under 10 sheets	No charge
10 sheets or more (including first 10 sheets)	.30 per sheet

STAFF SERVICE CHARGES (Searching files and xeroxing or monitoring the copying of records.)

Support Staff

First ½ hour	No charge
Excess ½ hour (including first ½ hour)	10.00 per hour

Technical Staff

First ½ hour	No charge
Excess ½ hour (including first ½ hour)	15.00 per hour

These charges were established by the Department of Environmental Resources consistent with Commonwealth policies and are subject to change without notice.

When requesting information for a specific area, it is important to identify the county, township and 7.5-minute quadrangle map name. If you are requesting a search for a particular well record you should also provide the name of the owner at the time the well was drilled, the year it was drilled and the driller's name, if possible.

Table 2 is a listing of the fees charged for the information and services provided by the staff of the Water Well Inventory Program. The Information is available from the WATER WELL INVENTORY PROGRAM, BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY, DEPARTMENT OF ENVIRONMENT RESOURCES, P.O. BOX 2357, HARRISBURG, PA 17120; Telephone 717-787-5828.

NAKAURIITE

A NEW BLUE MINERAL FROM CEDAR HIL

by John H. Barnes
PA. Geol. Survey

Ten years ago, Jujin Suzuki, Masahira Ito, and Tsutomu Sugiura published a paper describing their discovery of a copper sulfate-carbonate hydroxide hydrate from Nakauri, Aichi Prefecture, Japan. This was a new mineral that they named nakauriite (Suzuki and others, 1976). This sort of discovery takes place many times each year, and is noted in the major mineralogical journals. Often, mineralogists in the United States may give such a far-off discovery no more than passing notice. But this discovery was to prove to be of considerable significance in Pennsylvania and elsewhere in the United States. Indeed, ten years later, nakauriite is still a subject of controversy and great interest to those who study the mineralogy of Pennsylvania.

The description of nakauriite carried in the "New Mineral Names" section of the *American Mineralogist* (Fleischer, 1977, p. 594) indicated the mineral to be sky blue aggregates of slender to fibrous crystals, occurring in massive and sheared sepentinite. X-ray diffraction and optical properties were also given. This description turned out to fit quite well with the properties of a blue mineral discovered in the Cedar Hill serpentinite quarry in Lancaster County, Pennsylvania. The strange mineral had been spotted at Cedar Hill at least twice before 1976, in 1972 by Richard Haefner, who worked with Deane K. Smith of the Pennsylvania State University in an attempt to identify it, and in 1975 by Robert C. Smith, II, of the Pennsylvania Geological Survey and Robert B. Finkelman, then of the U.S. Geological Survey (Smith, 1978; Foord and others, 1985).

Everyone working with the material collected at Cedar Hill suspected that it was something new, but it proved difficult to work with, being of small quantity and containing antigorite as an impurity. It was not until several years after Suzuki, Ito, and Sugiura published their data that the identification of the mineral at Cedar Hill was confirmed, aided by two developments.

The first of these was the refinement of analytical data on nakauriite, carried out by Peacor and others (1982) as a part of the process of clearing up an unfortunate incident in which nakauriite was allegedly misrepresented by a mineralogist as two "new" minerals, "cuproartinite" and "cuprohydromagnesite." Peacor and

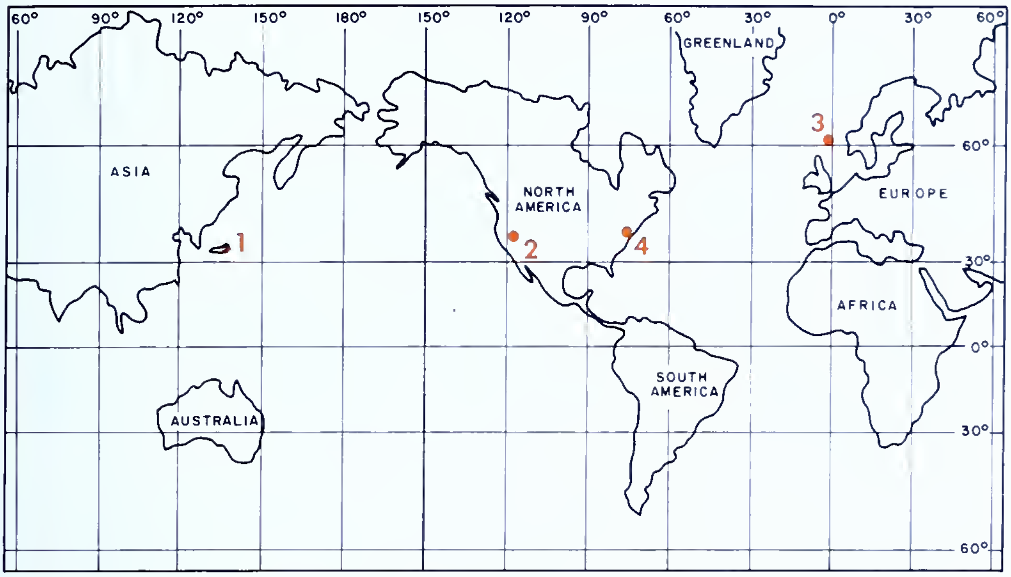


Figure 1. Locations known to contain nakauriite: (1) Nakauri, Japan (Suzuki and others, 1976); (2) Gabbs, Nevada (Peacor and others, 1982); (3) Unst, Shetland Islands (Braithwaite and Pritchard, 1983); and (4) Cedar Hill, Pennsylvania (Foord and others, 1985).

others improved upon the X-ray diffraction data for nakauriite, refined the unit cell parameters, and found evidence that the chemical composition reported by Suzuki and others (1976) was probably in error.

The other development was the collection of better specimens at Cedar Hill by mineral collectors Bryon Brookmyer of Harrisburg and Martin Anne of Wrightsville. Their specimens were larger and free of the antigorite contamination that had plagued earlier studies. They sent samples to Robert Smith, Deane Smith, and Eugene Foord and Allen Heyl of the U.S. Geological Survey in Denver, Colorado. Deane Smith also studied samples donated by another mineral collector, Thomas O'Neil of Montoursville. The identification of this material as nakauriite came from Robert Smith in April 1983 (Foord and others, 1985).

Additional studies were carried out on Pennsylvania material by Arnold H. Fainberg, an infrared spectroscopist with an interest in minerals. He found evidence agreeing with that of Peacor and others (1982) and Braithwaite and Pritchard (1983) that nakauriite contains no sulfate, suggesting that the initial description by Suzuki and others (1976) could, indeed, be in error (Foord and others, 1985).

Foord and others (1985) conclude, based on optical and chemical data, that there could be at least three species, or end members, making up a series of nakauriite-like minerals, one containing copper as a dominant component, one with nickel, and one with magnesium. A fourth species, with manganese as the dominant cation, is also possible. They indicate that, even ten years after its acceptance as a new species, additional work is needed to fully understand this mineral that has been a source of controversy and great interest to the mineralogical community. What is clear is that it is still possible to encounter very rare and attractive minerals that have not been previously known in Pennsylvania, and about which much remains to be learned.

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Survey Library Adds NHAP Photography

The recent acquisition of black-and-white NHAP (National High Altitude Program) photography has increased the aerial photography holdings of the Pennsylvania Geological Survey Library. Previously only color infrared images were in the Library collections. NHAP photo coverage for Pennsylvania spans the six year period from 1980 through 1985. The NHAP photography is the most current photography available from the U.S.G.S. Coverage is complete but for two narrow strips, one is to the west of Harrisburg in Franklin County and the second strip is east of Pittsburgh in Westmoreland County.

The photography purchased by the Pennsylvania Geological Survey is in a 9 x 9 inch contact print format and has a scale of 1:80,000 (1 inch = about 1.25 miles). A single photograph covers a ground area of almost 130 square miles.

Black-and-white NHAP photographs are ideally used for map-making, geologic studies, and engineering applications. They provide high-resolution and stereoscopic coverage needed for these types of applications. Each photograph in a flight line overlaps the next by sixty percent. The overlapped area can be viewed in three dimensions with the help of a stereoscope.

For more information or access to photographs, contact the Pennsylvania Geological Survey Library, the National Cartographic Information Center Affiliate for Pennsylvania.

Pa. Geological Survey Library
916 Executive House
P.O. Box 2357
Harrisburg, PA 17120
(717) 783-8077

EROS Data Center
U.S. Geological Survey
User Services Section
Sioux Falls, SD 57198
(605) 594-6151

NHAP

NHAP VIDEOTAPE AVAILABLE

A VHS videotape of the National High Altitude Photography Program has been released by the EROS Data Center of the U.S.G.S. Featured in the videotape is Viktoras Skema, geologist of the Pennsylvania Geological Survey, who has used NHAP photography in mapping Pennsylvania counties with bituminous coal resources. This videotape is available for use by schools and other groups interested in learning about the latest technology in obtaining and utilizing aerial photography.

NEW CAMBRIAN FOSSIL LOCALIT IN LANCASTER COUNTY

by John E. Ryan
Delaware Valley Paleontological Society

Lower Cambrian fossils may be collected at a small quarry on Harrisburg Pike, about 3 miles northwest of Lancaster, Pennsylvania. The quarry is owned by and located next to Brubaker, Inc. on the south side of Harrisburg Pike (L.R. 36184) about 300 feet west of its intersection with Rohrerstown Road (L.R. 36006) (40°04′12″N/76°21′36″W, Lancaster quadrangle; Figure 1). Fossils are found in loose blocks which compose several dump piles located in the northern portion of the quarry. Certain rock layers in the floor of the quarry near the dump piles are fossiliferous as well.

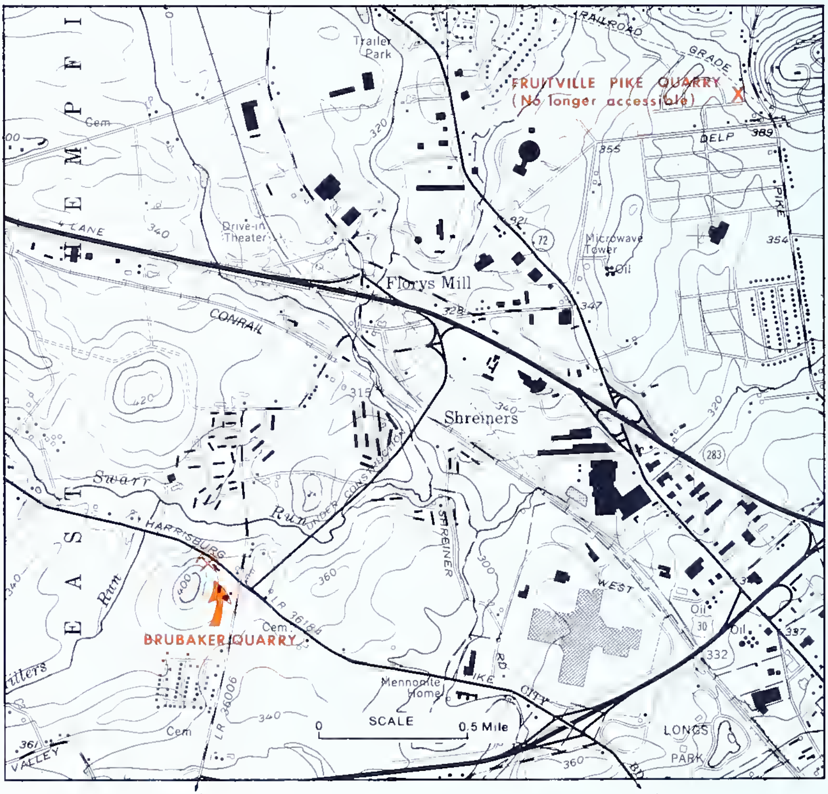

Figure 1. Location map.

The Company requires collectors to secure permission in advance and to sign a release. Persons wishing to visit the quarry should contact Donald Brubaker, President, Brubaker, Inc., 1284 Rohrerstown Road, Lancaster, PA 17601. IN NO EVENT MAY COLLECTORS VISIT THE QUARRY WITHOUT FIRST OBTAINING PERMISSION AND SIGNING A RELEASE. Collectors must abide by any company rules and must not litter or deface the quarry. It should be noted that the company is removing material from this quarry for construction use, and accordingly the site may disappear within the next few years.

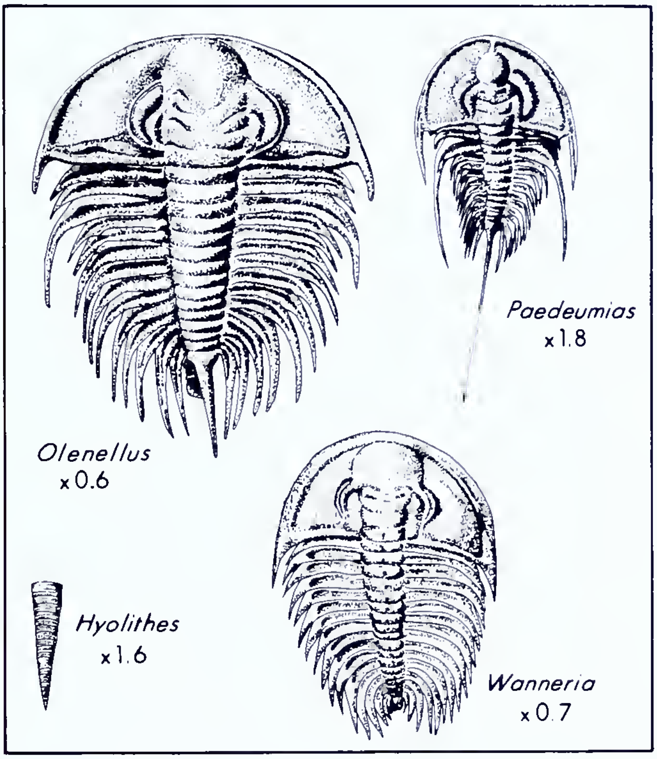

Figure 2. Typical Lower Cambrian fossils present at site. (Illustrations from Harrington and others, 1959, and Hoskins, 1969.)

The fossiliferous rocks exposed in the quarry are shales, siltstones, and sandstones belonging to the Kinzers Formation (Jonas and Stose, 1930; Meisler and Becher, 1971). These rocks show incipient metamorphism and compression, with many of the fossils exhibiting substantial distortion. The following fossils have been identified at this locality (Figure 2):

- Trilobites
  - *Olenellus*
  - *Paedeumias*
  - *Wanneria*
- Annelid?
  - *Hyolithes*
- Brachiopods
  - Unidentified valves

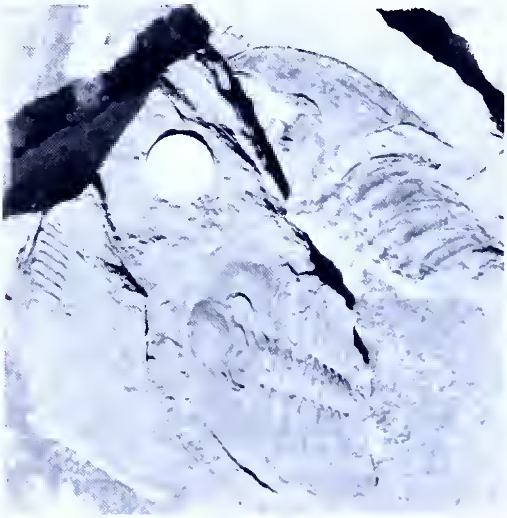

Figure 3. *Wanneria* specimens collected in Brubaker quarry. (Note quarter for scale.) (Photo by John D. Inners.)

The most interesting fossils found are the olenellid trilobites. While most trilobite finds consist of isolated cephalons or thoracic segments, articulated and partially articulated specimens can be turned up with persistent searching. The remains of the trilobite *Wanneria* often are quite large, with fragments from six-inch or larger individuals being not uncommon (Figure 3). *Hyolithes*, possibly an annelid fossil, is found as 1/8 to 1/2 inch conical molds.

A major problem facing the collector at this locality is the fact that compression of these rocks has resulted in cleavages which run at sharp angles to the original bedding. The rock splits much more readily along these cleavages than along the planes in which the fossils lie, and thus it is difficult to split the rock so as not to injure or destroy the fossils. The best method of collecting is to examine a block to ascertain the direction of the original bedding, and then to split the block along the bedding using a heavy hammer and a wide-bladed chisel. This method works fairly well, although the task of properly splitting these rocks is a challenge to the most experienced collector.

The fossiliferous rocks exposed at this locality were deposited in a shallow sea some 570 million years ago. These rocks contain a fauna similar to the Kinzers fauna found in the famous Fruitville Pike quarry (Hoskins, 1969) which now is owned by Franklin and Marshall College. The fact that articulated trilobite specimens are found regularly in the two quarries indicates that both faunas are life assemblages. The rocks exposed in the Harrisburg Pike quarry, however, are somewhat coarser grained than those in the Fruitville quarry. Perhaps the shoreline was closer to the sea floor on which the Harrisburg Pike quarry organisms lived than was the case for the Fruitville faunal assemblage.

The author wishes to thank Jon D. Inners of the Pennsylvania Geological Survey, Milton and David Funk of Funk Brothers, Inc., and Donald Brubaker of Brubaker, Inc., for their assistance in the preparation of this article. Jeffrey K. Jones, formerly of the Academy of Natural Sciences of Philadelphia, aided in the initial field investigation of the site.

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New U.S. Geological Survey Report on Pennsylvania Surface-Water Resources

Pennsylvania's surface-water resources — 45,000 miles of streams, more than 2,300 reservoirs and 76 natural lakes — have been a major factor in the state's growth, according to the Pennsylvania section of the 1985 National Water Summary by the U.S. Geological Survey, Department of the Interior.

The 1985 National Water Summary is the third in an annual series of comprehensive reports on the status and supply of the nation's vital water resources. It provides an extensive state-by-state look at the country's surface-water resources, which provide about 80 percent of the daily water needs of the United States.

David E. Click, District Chief of the U.S.G.S. Water Resources Division office in Harrisburg, Pa., estimates that 94 percent of the state's total water use is from surface-water supplies.

Table 1. Surface-water facts for Pennsylvania

[Data may not add to totals because of independent rounding Mgal/d = million gallons per day; gal/d = gallons per day; < = less than. Source. Solley, Chase, and Mann, 1983]

POPULATION SERVED BY SURFACE WATER, 1980	
Number (thousands)	6,620
Percentage of total population	56
From public water-supply systems.	
Number (thousands)	6,620
Percentage of total population	56
From rural self-supplied systems.	
Number (thousands)	0
Percentage of total population	0
OFFSTREAM USE, 1980 FRESHWATER WITHDRAWALS	
Surface water and ground water, total (Mgal/d)	16,000
Surface water only (Mgal/d)	15,000
Percentage of total	94
Percentage of total excluding withdrawals for thermoelectric power	83
Category of use	
Public-supply withdrawals:	
Surface water (Mgal/d)	1,300
Percentage of total surface water	9
Percentage of total public supply	87
Per capita (gal/d)	196
Rural-supply withdrawals:	
Domestic:	
Surface water (Mgal/d)	0
Percentage of total surface water	0
Percentage of total rural domestic	0
Per capita (gal/d)	0
Livestock	
Surface water (Mgal/d)	7
Percentage of total surface water	<0.1
Percentage of total livestock	11
Industrial self-supplied withdrawals:	
Surface water (Mgal/d)	13,000
Percentage of total surface water	90
Percentage of total industrial self-supplied	
Including withdrawals for thermoelectric power	96
Excluding withdrawals for thermoelectric power	86
Irrigation withdrawals:	
Surface water (Mgal/d)	140
Percentage of total surface water	0.9
Percentage of total irrigation	88
INSTREAM USE, 1980	
Hydroelectric power (Mgal/d)	81,000

"Because of the great dependency on surface water, most critical water issues in Pennsylvania relate to high or low flows, available storage, and/or the quality of the source."

Single copies of the Pennsylvania section of the 1985 National Water Summary are available from the District Chief, U.S. Geological Survey, P.O. Box 1107, 4th Floor, Federal Bldg., 228 Walnut St., Harrisburg, Pa. 17108.

Each state section contains maps and graphs that portray runoff and precipitation; the location of principal rivers, reservoirs and hydropower plants; trends in average streamflow discharge; how surface-water resources are managed and a table on surface-water use.

Copies of the entire 506-page 1985 National Water Supply, including all state sections plus an overview of hydrologic conditions for the 1985 water year are available for $31 each. Orders must include check or money order payable to Department of the Interior-U.S.G.S. and should be directed to: U. S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 41, Box 25425, Denver, Colo. 80225.

U.S. Geological Survey Consolidates Map and Publication Distribution Facilities

The U.S. Geological Survey has begun consolidating its facilities for nationwide distribution of maps, scientific books and reports, and general-interest publications into a single building in suburban Denver.

The consolidation will result in phasing out the USGS Eastern Distribution Branch, which has facilities in Arlington and Alexandria, Virginia and was scheduled to be completed by September 30, 1986.

The Eastern Distribution Branch will merge with the Western Distribution Branch, now in Building 41 at the Denver Federal Center in suburban Lakewood, Colorado, to form the consolidated facility.

After consolidation, map distribution services for all states will be provided by the U.S. Geological Survey, Map Distribution Section, Federal Center, Box 25286, Denver, Colorado 80225.

The consolidation will not affect customer service at the more than 2,800 private map dealers in the nation who sell USGS topographic maps. They will continue to provide this service in their respective state and regional market areas.

The Eastern Distribution Branch facility at 604 South Pickett Street in Alexandria, Virginia, which sold and distributed USGS professional papers, bulletins, circulars, general-interest publications and other book products has terminated all sales.

Distribution from the Alexandria facility is being shifted to the U.S. Geological Survey, Books and Open-File Reports Section, Federal Center, Box 25425, Denver, Colorado 80225.

Although the Eastern Distribution Branch facilities in Alexandria and Arlington are being closed, over-the-counter services for USGS maps and reports will continue at two USGS Public Inquiries Offices in the Washington, D.C. area. The PIO in Room 1028 of the General Services Administration Building, 18th and F Streets, N.W., Washington, D.C., and the PIO in Room 1C402 of the USGS National Center, 12201 Sunrise Valley Drive, Reston, Virginia, will continue selling limited numbers of maps and books. Large orders should be directed to the consolidated facility in Denver.

THE WORLD IN ROCKS

THE LATEST SURVEY SUCCESS STORY

Aaron M. Ford
1657 E. 126th St.
Compton, Cal. 90222
May 5, 1986

Pennsylvania Geological Survey
Harrisburg, PA 17120

Dear Dr. Socolow,

When I wrote to you and requested a rock and/or mineral specimen, for my Science Fair entry, I promised to let you know how I did with my entry. Well, I am very proud to let you know that I took FIRST PLACE in Earth and Science.

I am planning on entering again next year, in the same catagory. I will expand my exhibit by including polished rocks, gems, rocks from other countries, and I want to try and design or invent something made out of rocks. I'm sure I should be able to come up with something between now and next April.

I want to THANK YOU VERY MUCH for your time, effort, and consideration. All of the material and information was truly helpful. If it weren't for you, I couldn't have presented, " THE WORLD IN ROCKS" exhibit.

I am looking forward to doing business with you again next year.

Sincerely,

Aaron M. Ford
Aaron M. Ford

Geochips

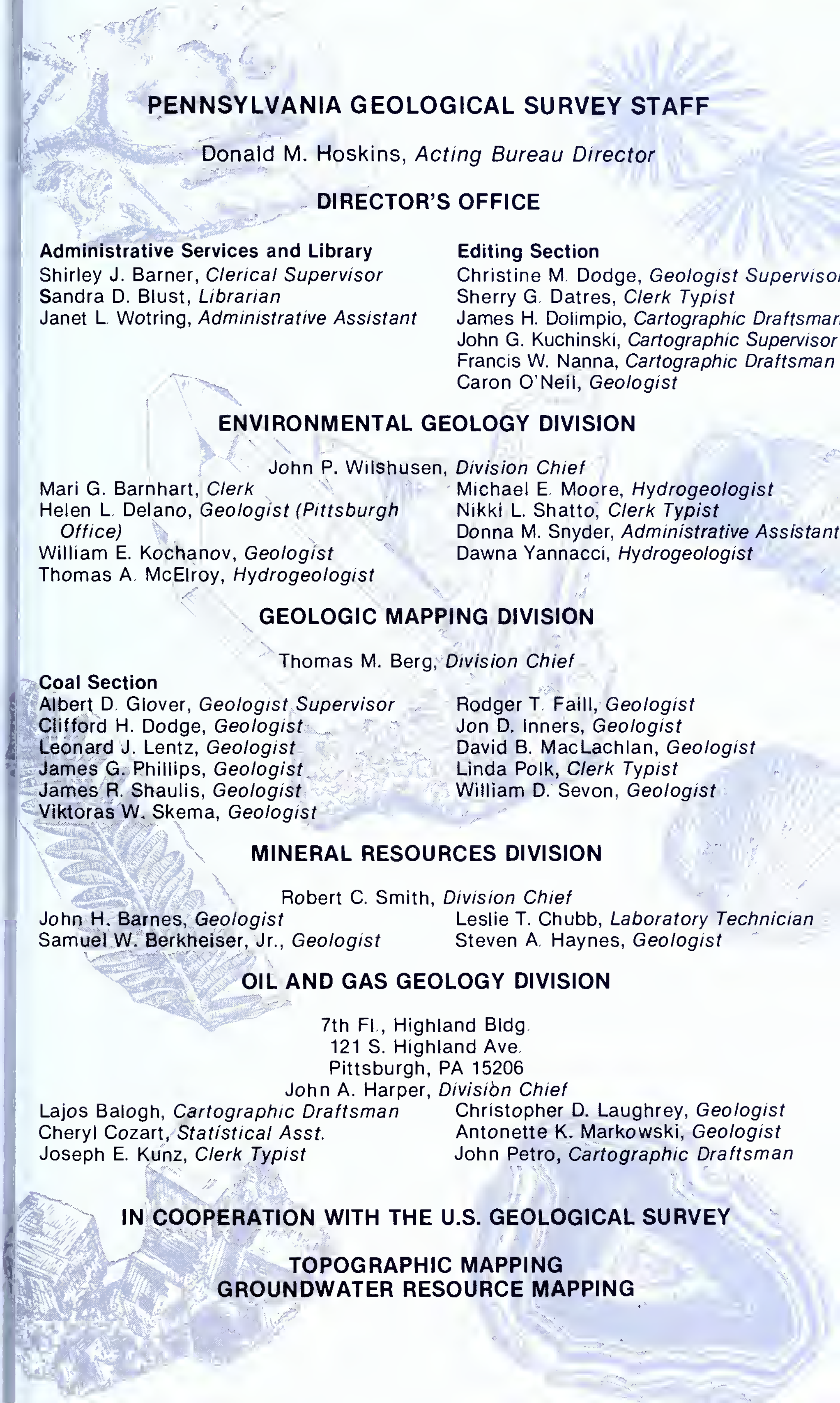
Mike Shaffner told this story to Bill Lytle many years ago, and Bill related it to the staff of the Oil and Gas Geology Division in Pittsburgh:

During one summer in the late 1930's or early 1940's the Survey received the services of a young fellow who was apparently a political appointee. He didn't really know anything about geology or he wouldn't have done what he did. George Ashley, who was the State Geologist at that time, gave him the job to go out and make an areal survey of some area around Harrisburg. Although the fellow was expected to report back at periodic intervals, nobody heard from him for some time. After about a month Ashley directed someone to contact the fellow and tell him to come in so his work could be reviewed.

When the fellow finally came in, Ashley asked him how his work was coming along. The fellow replied that he was doing okay and got out his maps. Ashley couldn't see much on the maps, just a few dots or something, so he asked, "What's all this?" The young man replied, "Well, you wanted me to make an aerial survey, so I got a radio and put it in my car and went around to all these different areas to see how the reception was. I've marked on the map where the reception was good and where the reception was bad, and where I couldn't get anything I marked that, too."

Ashley threw up his hands, and I guess that was the end of that!

GEOCHIPS will be presented in the issues of *Pennsylvania Geology* during our Sesquicentennial year. As we celebrate 150 years of pondering the geology of the Commonwealth, *GEOCHIPS* will share some of the human side of our geologists' life at the Pennsylvania Geological Survey.



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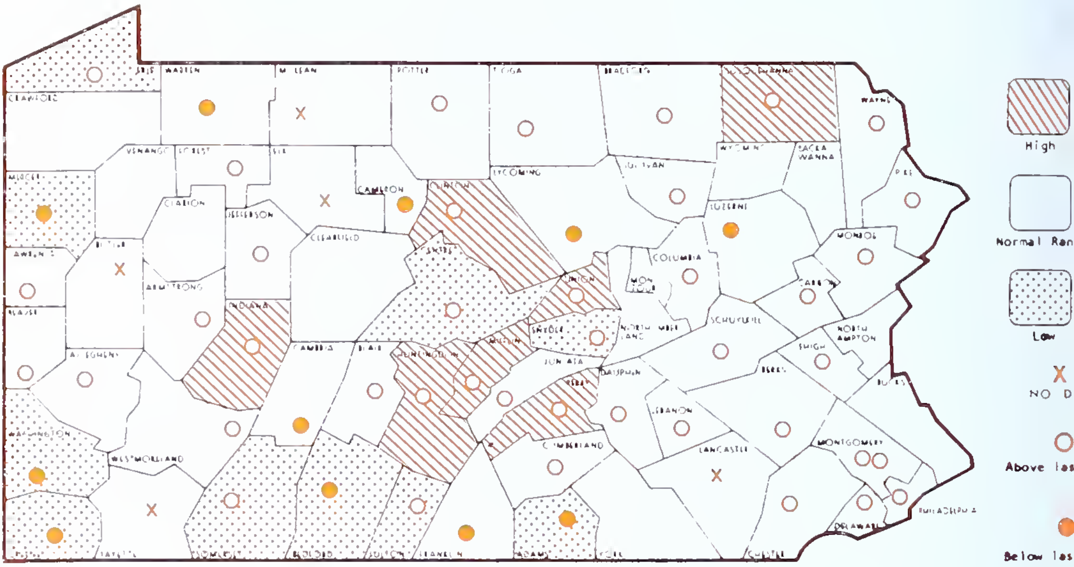

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TOPOGRAPHIC AND GEOLOGIC SURVEY

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ON THE COVER: Reproduction of a portion of a copper plate lithograph entitled "Part of Summit mine of Lehigh County, looking west", sketched by George Lehman, an artist employed by Henry D. Rogers in the 1840's to illustrate *The Geology of Pennsylvania, a Government Survey,* published in Philadelphia, Pa. in 1858.

PENNSYLVANIA GEOLOGY is published bimonthy by the Topographic and Geologic Survey, Pennsylvania Dept. of Environmental Resources, Harrisburg, Pennsylvania 17120.

Editor, Donald M. Hoskins.

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VOL. 17, NO. 6 **DECEMBER 1986**

CREDIT WHERE CREDIT IS DUE

The success of any organization is firstly the success of a
dividual, and only secondarily the success of the organization
Survey is composed of geologists, hydrogeologists, clerks
typists, cartographic draftsmen, administrative and statis
assistants, laboratory technicians and a librarian, all of whom
worked, in most cases, for many years as civil servants. They
devoted themselves to providing the best possible geological
hydrogeological information about our Commonwealth.

Recently three of the Survey's staff were honored by our De
ment and were given awards for excellence in their individual
If our Survey is in any way perceived as providing excellent pu
service it is due to the efforts of such people as these. And they
but a sampling of the bureau's personnel, all of whom can be
sidered for such awards in their own project or program res
sibility. And thus we give credit where credit is due to—

JANET L. WOTRING

WILLIAM D. SEVON

CHERYL COZA

Mining Today—Rising to the Challenge[1]

by Ann Dore McLaughlin[2]

The mineral industry today faces challenges that will test severely the ability, creativity, and flexibility of its managers, and I see these challenges reflected in this "compass-word"—competition. It is sometimes misunderstood. Cynics do not believe in it. But I know this audience understands competition. You see more competition in one day than most businesses see in a lifetime. Because of the abundance of coal in this Nation, domestic producers have to compete vigorously among themselves for a market. Also, you have seen nuclear power swallow a portion of the traditional utilities market. You see some cement plants recently switching to natural gas. You see Australia, Canada, South Africa, and, most notably, Colombia offering coal in the international market at increasingly competitive prices. You see the price of oil dropping to the point that new coal-fired generating plants currently are uneconomical to build. You saw the highest barrier to overseas sales was not some foreign tariff, but our own bloated dollar!! So, there is nothing I can really tell you that you haven't learned first hand and long ago about this "compass-word" competition.

The most influential economist of our time is not Lord Maynard Keynes, with his brief for hugh government spending, but an Austrian most Americans have never heard of—Joseph Schumpeter. Schumpeter saw the key to the effectiveness of a free economic system in what he called "creative destruction." By that he meant those endeavors that are unable to respond to changing needs and demands are destroyed by those more creative endeavors that see the needs and respond to them. The main thrust of his economic theory is that capitalist society owes its dynamism, its capacity to produce the most for the greatest number at the lowest price, to the creative destruction caused by the unremitting pressure of competition. Anyone who has studied the way our system operated from the very beginning knows this to be a hard fact of industrial life. There must have been conventions of the American Society of Buggy Whip Makers even while Henry Ford was tinkering around the barn.

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[1] Excerpted remarks presented to the American Mining Congress Coal Convention, Pittsburgh, PA, May 5, 1986. Although primarily intended for an audience of coal producers and related service industries, these remarks contain some thought provoking questions and challanges that face Pennsylvania's entire mineral industry. Full text is presented in the USBM (1986), Minerals and Materials, April/May, p. 1-5. Reprinted with the author's permission.

[2] Under Secretary of the U.S. Department of the Interior.

It is clear from this example that it was not just something called "competition" that whipped the buggies. It was rather two other aspects of any economic system that isn't stone dead or controlled by the state. First, a changing environment; and, second, an incapacity to see that the environment is changing, or an unwillingness to adjust, or both.

Now, what am I leading up to? That the coal industry is the equivalent to making optional equipment for horse-drawn vehicles? Far from it. Even as we all see the clouds currently over the industry, we know that somewhere down the road, after much sweat, blood, and tears, you are going to be covered with sunshine. OPEC, like a volcano, is only sleeping. Nobody is creating more oil, worldwide demand is rising, and the oil being found is more expensive to drill. One of these days we will all be back once again on the coal standard. But, meanwhile, how do we get from here to there?

We have to realize that the environment has changed. The nuclear genie, despite the accident in the Ukraine, will not be pushed back into the atom. Concern about the environment will not go away. The demand for safe workplaces is not a sometime thing. And you are determined to be creative rather than destroyed. If you wish to rise to the challenge of competition and change, what must be done? Where do you begin? What do I suggest? Five keys. These five important, vital, interrelated steps are, first, look within; second, measure strength; and third, fourth, and fifth, commit yourselves to innovate, innovate, innovate.

LOOK WITHIN!
MEASURE STRENGTH!
INNOVATE!
INNOVATE!
INNOVATE!

Looking within we find an industry facing substantial domestic competition from oil and, due to the now global reach of technology that has broadened the competitive base internationally, a potential competitive challenge from overseas producers. Traditional market expansion appears very modest, and profit margins are probably thin due to the modest growth potential and the ability of the industry at present to easily absorb this growth within existing production capacity. In short, I see the industry approaching a period of heightened competition with all the potential for "creative destruction" noted by Schumpeter.

Key number two, measuring strength means recognizing that trends are not fate, that while competition is a hard fact of life, change can be harnessed. I am distressed by the reaction of some in the industry, who list a parade of horribles—starting with reduced investment in research and development—that sound very similar to a bureaucratic response to budget cuts. It is a bureaucratic truth that, if your office is faced with a budget cut, you respond by cutting the most important, most visible program you have. Thus, in the case of National Park Service, the first action you take is reducing the hours or closing the doors to Washington Monument.

This brings us to the main point of my comments - the need to innovate, innovate, innovate. On a level playing field we can compete with, or we can outcompete with, anyone if we build on our strength and cure our weaknesses. As Peter Scott, Chairman and CEO of Emhart Corp., put it in a recent Wall Street Journal op ed piece, ...“In our cozy maturity we looked at our remarkable manufacturing accomplishments and thought we saw, reflected, the whole course of our future. A guaranteed future. “We were wrong. Dead wrong!” he adds. “We were wrong because we didn’t see that what made America strong is our history of rejecting guaranteed future. We became what we were because we worked, and risked, and invented. “Competitiveness cannot be legislated. We have to become more competitive by changing our fundamental thinking.”

There have been recent innovations in the coal industry, of course. But where is the determination to conduct major, focused research and development? Where are the research institutes and centers, the intense search for new ways to mine coal, to use it, to break it down into new products, to contend through science, not legislation, with environmental constraints? To develop new markets?

The challenge you face is cause to look deep into the very fundamental assumptions about how you do business and where the future lies and to act, not react, to develop your competitive edge.

New Staff of the Pennsylvania Geological Survey

Antonette K. Markowski

Antonette K. Markowski joined our Bureau in June, 1986 as an Oil and Gas Geologist assigned to the Pittsburgh office. Toni will engage in investigations on the oil and natural gas geology, stratigraphy and structural geology of subsurface rocks of Pennsylvania, and provide geologic service to requestors of information on oil and gas geology.

Toni has a B.S. degree in Earth Science/Environmental Education from Shippensburg University in 1978 and did graduate work at Millersville University and Southern Illinois University.

Toni previously worked as a Geologic Aide for the Bureau of Topographic and Geologic Survey in the Harrisburg office and we welcome her back.

Michael E. Moore

Michael Moore joined the Bureau of Topographic and Geologic Survey in June, 1986 as a hydrogeologist in the Environmental Geology Division. His current assignment is a study of the groundwater resources of Warren County.

Mike brought to the Survey a Penn State Bachelor of Science Degree in geology and more than eleven years of applications in the fields of geology and engineering. While the majority of his experience is in the environmental aspects of bituminous coal mining, he has participated in projects ranging from the cleanup of hazardous waste spills to the design of wastewater treatment plants.

Dawna S. Yannacci

Dawna S. Yannacci joined the Environmental Geology Division of the Bureau of Topographic and Geologic Survey in Harrisburg as a hydrogeologist in October 1986. Her initial work will include participation in a cooperative study with the U.S. Geological Survey on the aquifer characteristics of the rocks of Pennsylvania.

Dawna was raised in Darragh, Westmoreland County, Pennsylvania and graduated from Juniata College in 1981 with a BS in geology. She received an MS degree in geology from Kent State University in May, 1986. We welcome Dawna to our staff.

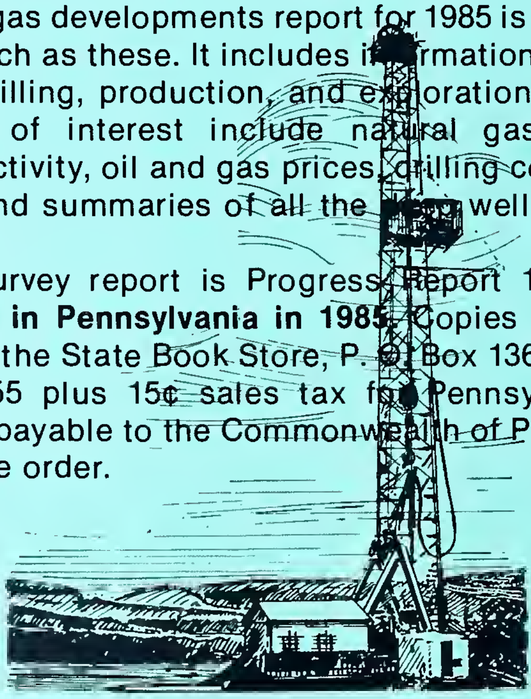
New Survey Publications

Pennsylvania's 1985 Oil and Gas Developments

The Bureau of Topographic and Geologic Survey has released its annual report of the oil and gas industry in Pennsylvania for 1985. The industry reported 4,657 new wells drilled in the Commonwealth during 1985, a 79 percent increase over the number reported in 1984, and it broke the old record of 4,224 wells reported that was set in 1982. The total included 2,471 oil wells, 1,894 gas wells, 77 combination oil-and-gas wells, 104 service wells, and 111 dry holes. Although the number of dry holes increased by 83 percent from 1984, the "success" rate for all wells drilled remained at 98 percent. Oil production for 1985 was 4,850,968 barrels, and gas production was 150,541 million cubic feet, for a total value of approximately $596 million. Recoverable oil reserves declined slightly to 53,007,000 barrels, and gas reserves increased slightly to 1,979,369 million cubic feet. Some interesting exploratory and development highlights continued expansion of fields in Clearfield and Centre Counties, and the discovery of Macedonia pool in Erie County.

The oil and gas developments report for 1985 is replete with facts and figures such as these. It includes information on all aspects of oil and gas drilling, production, and exploration in Pennsylvania. Other topics of interest include natural gas storage areas, geophysical activity, oil and gas prices, drilling costs, activities on state lands, and summaries of all the deep wells reported during the year.

The new Survey report is Progress Report 199, **Oil and Gas Developments in Pennsylvania in 1985.** Copies of the report are available from the State Book Store, P. O. Box 1365, Harrisburg, PA 17105 for $2.55 plus 15¢ sales tax for Pennsylvania residents. Checks made payable to the Commonwealth of Pennsylvania must accompany the order.



FREDERICK AUGUSTUS GENTH - - QUINTESSENTIAL SCIENTIST

by John Barnes
Pennsylvania Geological Survey

Laboratory of the University of Pennsylvania,
Philadelphia, December 31, 1874.

Prof. J. P. Lesley,
State Geologist:

SIR: — In obedience to instructions, I have prepared and have now the honor to submit the accompanying *Preliminary Report* on the Minerals found in the State of Pennsylvania.

These words, written in the formal manner that was the custom a century ago, begin the first state-sponsored survey of the mineralogy of Pennsylvania, undertaken as a part of the Second Geological Survey of Pennsylvania. They were written by a man who, by training, temperament, and experience, was well-qualified to undertake such a formidable task.

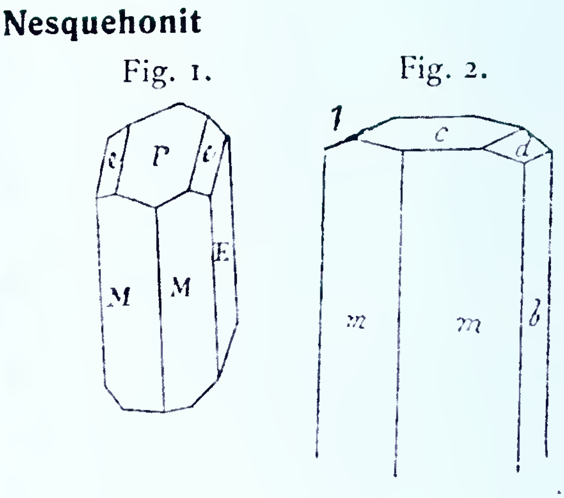
Friedrich August Ludwig Karl Wilhelm Genth was born on May 17, 1820, in the village of Waechtersbach, in the German state of Hesse; the son of the high warden of the forests to Prince Issenbourg. It is from his father that Friedrich is said to have received early training that developed his powers of observation and his interest in the natural sciences (Barker, 1902).

The young Genth received formal training at the Hanau Gymnasium, the director of which called attention to his great interest in the natural sciences. After studying chemistry, geology, and mineralogy at the University of Heidelberg, he continued his studies by specializing in chemistry at the universities at Giessen and Marburg. Upon receiving his doctorate from the University of Marburg, he remained there for three years as assistant to his mentor, the emminant Professor Robert Wilhelm Bunsen (Barker, 1902; Myers and Zerfoss, 1946).

In 1848, Genth left Marburg, and Germany, and sailed to Baltimore. He soon established a chemical laboratory in Philadelphia, which he left in 1849 when offered a position as superintendent of a mine in North Carolina. In 1850 he returned to Philadelphia, where he was to remain, reopening his private laboratory, establishing relationships with the Geological Survey, the Pennsylvania Board of Agriculture, and the University of Pennsylvania, all while carrying out independent research projects on subjects of interest to him (Barker, 1902; Myers and Zerfoss, 1946).

Genth's work in mineralogy was prodigious not only in quantity, but also in scope. As his reputation grew, and he established contacts with the leading scientists of his day, specimens of interesting minerals from many places were submitted to him for his analysis. He shared the results of his work through proceedings of the American Philosophical Society and the Philadelphia Academy of Natural Sciences, and especially through a series of papers called "Contributions to Mineralogy," most of which were published in the *American Journal of Science.* Most of these papers presented news of activity in the Genth laboratory, which might include a study of apophyllite from the Bay of Fundy (Genth, 1853a), aciculite from Beresofsk, Siberia (Genth, 1855), a "so-called Gibbsite" from Chester County (Genth and Penfield, 1890b), or an occurrence of arsenate of cobalt with pyrite at French Creek, Chester County (Genth, 1890). A single paper included descriptions of lanthanite from Bethlehem, bismuthine from Sweden, and wavellite from Chester County (Genth, 1857). One topic in which he took special interest was the serpentine bodies of Chester and Lancaster Counties, and the associated chromium ore (Genth, 1862b, 1866). In an open letter to Professor Dana, he stated that the discovery of a large crystal of "chrysolite" (olivine) from "...the great (or once great) chrome mine, called Wood's mine...confirms my views as to the parent rock of the serpentine and talc of the chrome region" (Genth, 1866, p. 120), a view that is still held today, that the serpentine formed from alteration of olivine.

Nesquehonite, a mineral originally discovered in Schuylkill County and first described by F. A. Genth (Genth and Penfield, 1890a). (Illustration from Goldschmidt, 1920).



Genth observed the conventions of courtesy, but he was not one to look the other way when he felt that his work was unfairly questioned. For example, in one installment of "Contributions to Mineralogy" he states:

> It is with great regret that I feel it my duty to investigators to call their attention to several omissions and misapprehensions in Rammelsberg's great work, "Mineralchemie," which I consider of too much importance to be allowed to pass unnoticed. Not intending to write a criticism of the work itself, I will limit my remarks to those investigations only, which have been made in my laboratory either by myself or under my immediate supervision (Genth, 1862a, p. 204).

He then proceeds to present two pages of such remarks, such as this answer to a question concerning one of his analyses:

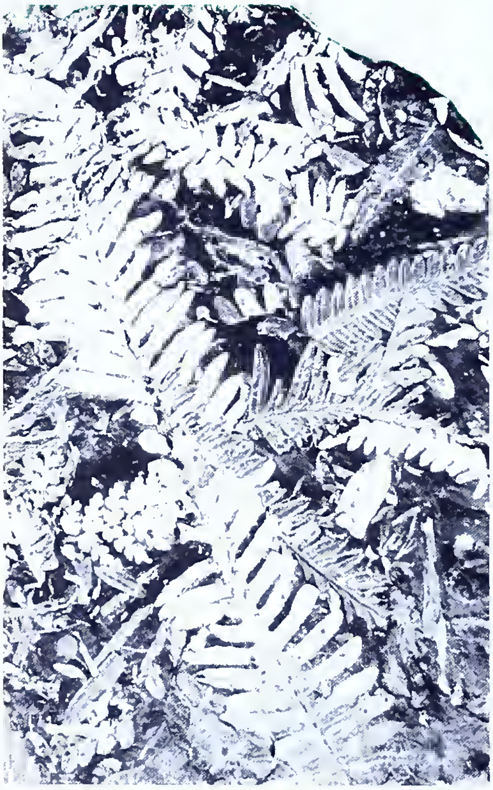
> My analyses are of course open to re-examination by any chemist, provided he uses the same material upon which I operated and equal care, and criticisms based upon such re-examinations are perfectly justifiable. But wherever that has not been done, I earnestly protest against an author casting a shadow of doubt over my investigations, when I know that all pains have been taken to furnish reliable information (Genth, 1862a, p. 205).

Genth described several new mineral species, among them lansfordite and nesquehonite from Schuylkill County (Genth and Penfield, 1890a), penfieldite from Laurion, Greece, named for the crystallographer with whom he collaborated in his later years (Genth, 1892), and "owenite," which Genth collected himself at Harpers Ferry, Virginia (now West Virginia) (Genth, 1853b), but which he soon withdrew after recognizing it as identical with thuringite, claiming he had placed "too much confidence in Prof. Rammelsberg's analysis, to think it would need a repetition, since the difference was about 16 pr. ct. of alumina" (Genth, 1854, p. 411).

Other topics to which Genth devoted his time, and which he addressed in publications outside the "Contributions to Mineralogy" format, included a study of the Gap Nickel Mine, Lancaster County, published in Germany shortly after his arrival in America (Genth, 1851). He also studied unusual white plant fossils from the anthracite fields of Schuylkill County (Genth, 1879) and discovered that they are composed of the mineral pyrophyllite, a discovery that that is still news to many people one hundred years later. He took an interest in the discovery of gold at Sutter's Mill, California, publishing a report on the minerals associated with gold in that state (Genth, 1852). Closer to home, after panning sand and gravel from a cellar on Arch Street in Philadelphia, finding magnetite, ilmenite, zircon, garnet, and olivine, he wrote, "The observed mineral generally accompany gold, but not a particle of the latter could be found. This negative result, however, does not prove its absence..." (Genth, 1871, p. 439). Genth also devoted much effort to formulating a concept concerning the role of corundum as a primary mineral in pegmatites, from which many other minerals were proposed to have formed by alteration (Genth, 1873, 1882). Unlike his idea of primary olivine being the source of serpentine bodies, this concept has not stood the test of time. Experimental evidence has indicated that a magma is not likely to contain sufficient alumina to form appreciable quantities of primary corundum (Deer and others, 1962).

Genth spent eight years associated with the Second Geological Survey of Pennsylvania, beginning in 1874 (Lesley, 1886). During this time he remained in Philadelphia. His most significant lasting contribution in that role was undoubtedly his *Preliminary Report on the Mineralogy of Pennsylvania,* published in 1875. This 238-page report gave descriptions, physical properties, localities, and some chemical analyses for 173 minerals known to exist in Pennsylvania at that time. Of that total, 14 are not considered mineral species today and 23 were not verified as occuring in Pennsylvania as of 1975 (Smith, 1978). This means that of the 276 species verified for Pennsylvania according to Smith (1978), an impressive 136, or 49%, were known to Genth a century earlier, before the advent of X-ray diffraction, electron microprobes, and other modern methods of mineral identification!

Pennsylvanian plant fossils composed of the white mineral first identified by F. A. Genth as pyrophyllite (Genth, 1879). (Specimen from St. Clair, Schuylkill County, collected by Alan R. Geyer).



One year after this *Preliminary Report* appeared, a *Second Preliminary Report on the Mineralogy of Pennsylvania* was published (Genth, 1876), containing updated information on some species, information on an additional species (strontianite), and data on the waters of certain springs in Pennsylvania. The letter of transmittal to the State Geologist, Professor Lesley, indicated this to be a report of progress for the year, and suggested that further work would be done on investigating the "crystallographic peculiarities" of the minerals, which had not been dealt with in either volume. He also indicated that the study of rock bodies was of great importance. "Henceforth, I intend to devote the greater part of [my time] to this very important subject, in order to embrace the results of the labors of some of your assistants and my own, in a Lithology of Pennsylvania" (Genth, 1876, p. vii).

But the *Lithology of Pennsylvania* did not appear, nor did any further reports on the mineralogy of Pennsylvania. Genth's association with the Second Geological Survey continued until 1882 (Lesley, 1886), but the only other published report that we have covering this period is a section of *The Geology of Philadelphia County and of the Southern Parts of Montgomery and Bucks,* by Charles E. Hall (Hall, 1881). The contribution by Genth, co-authored by his son, F. A. Genth, Jr., consisted of numerous chemical analyses of rocks of that region. According to Hall's letter of transmittal to Governor Hoyt, the analyses included in this report represented only a portion of the work of Genth, "...special lithological investigations of these and other rocks of the State, by Dr. Genth are reserved for publication in his own Mineralogical Report" (Hall, 1881, p. v), a report, again, that did not materialize. We can only presume that Genth conveyed much valuable information to the Second Geological Survey in unpublished form.

Genth's contribution to the understanding of the mineralogy of Pennsylvania was by no means the first by the Pennsylvania Geological Survey. In the report of the First Geological Survey, H. D. Rogers included an extensive list of "Localities of well-characterized crystalline minerals within the gneissic districts of Pennsylvania" (Rogers, 1858, p. 709-711), among other contributions. But Genth's work has left us a milestone, the *Preliminary Report on the Mineralogy of Pennsylvania* being, to our knowledge, the first comprehensive report dealing with the mineralogy of the entire state. It established a base upon which others have built, in particular as seen in the series of mineralogies of Pennsylvania by Gordon (1922), Montgomery (1965), and Smith (1978).

A short article such as this cannot even list all of Genth's accomplishments, much less properly discuss the many ramifications that his work still carries. As we have seen, Genth's interests were not centered only on Pennsylvania, or even on the subject of mineralogy. Among his publications are analyses of Egyptian obelisks, the soils and waters of Palestine, and Chinese coins; experimentation with wood gases; and a series of reports on the analysis of fertilizers for the Pennsylvania Board of Agriculture (Barker, 1902; Myers and Zerfoss, 1946). Genth appears to have been a man of great talent, inexhaustable energy, and wide-ranging interests, who was fortunate enough to be able to apply his talent and energy toward a greater understanding and appreciation of the world. That he was able to channel a portion of that talent and energy toward the efforts of the Second Pennsylvania Geological Survey is one of the things that we celebrate as we look back this year; a significant part of the history and traditions of this 150-year-old institution.

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In Memorium

Robert C. Fenton

Robert C. Fenton, a staff member of the Topographic and Geologic Survey in the Bureau's Pittsburgh office, died August 19, 1986 in Pittsburgh from complications following skin-graft surgery. Bob, who was a native of the Pittsburgh suburb of Blawnox, came directly from high school graduation to work for the Oil and Gas Geology Division of our Survey as a Laboratory Technician. He spent the early part of his 15 years with the Survey preparing oil and gas well-cutting samples and assisting in geological laboratory work. For the last ten years, however, Bob's primary responsibility had been accurately locating new oil and gas well locations on the Division's oil and gas maps, a vital part of the Survey's commitment to providing quality information to the public.

Bob's quick wit and sharp sense of humor were an important and familiar part of the Pittsburgh office. He was rarely at a loss for a joke and was capable of enlivening any situation with his seemingly inexhaustive supply of one-liners.

Bob, who was only 32, is survived by his wife, Mary Beth, and their daughter Molly. He will be sorely missed by his colleagues in

Pittsburgh, other Bureau staff who shared the laughter from his wit, and by the users of the Bureau's maps on which Bob painstakingly plotted with care and accuracy.

Norman K. Flint

Dr. Norman K. Flint, Professor Emeritus of Geology at the University of Pittsburgh, died at his home on October 18, 1986 after a short bout with cancer. He was 65 years old. At the time of his retirement in 1983, Dr. Flint, or Norm to those of us who knew him, had spent 35 years at the University of Pittsburgh teaching, conducting or overseeing research, and consulting.

Many readers will remember Dr. Flint, perhaps, for his report, "Geology of Southern Somerset County", which was published by the Pennsylvania Geological Survey as County Report 56A. He authored or co-authored two dozen published technical and three dozen unpublished consulting reports during his career. He became well known in the mid-1960's for his work on landslides and other geological hazards in the Pittsburgh area.

Despite these activities, however, Dr. Flint will be best remembered as an outstanding teacher who was totally committed to his students, whether in the classroom or the field.

In addition, Dr. Flint will be remembered as a scientist who contributed his geological abilities to his community.

With the death of Dr. Norman K. Flint, Pennsylvania and the science of Geology have suffered a great loss.

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TOPOGRAPHIC MAPPING
GROUNDWATER RESOURCE MAPPING

GROUNDWATER LEVELS
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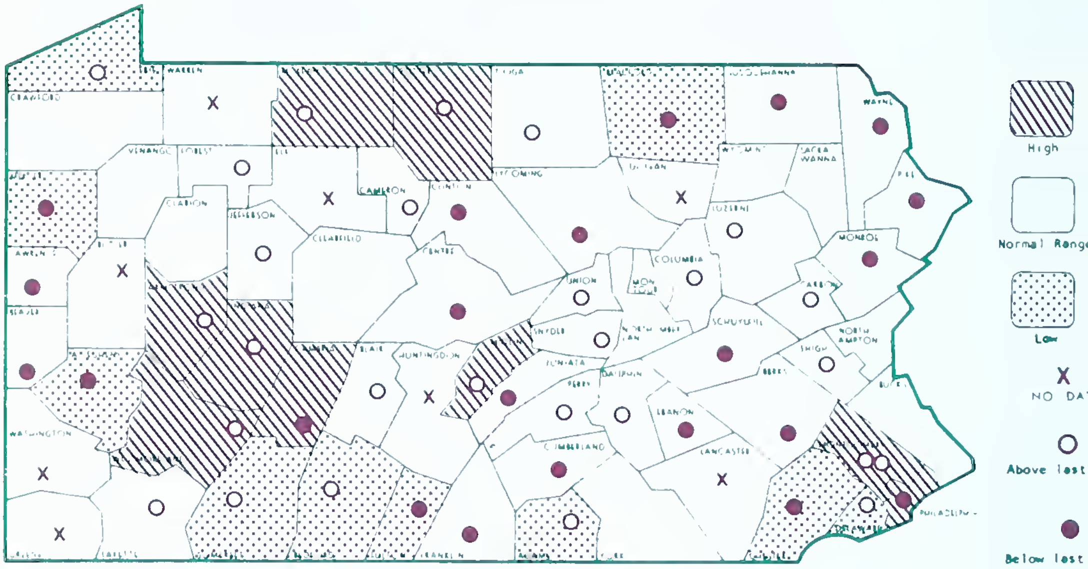

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